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Relief of Formed Milling Cutters—I

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When faced with an emergency demand for a formed cutter of the type usually bought outside, many shops are at a loss as to how to proceed. The author presents the fundamental principles of tool relief and describes their practical application

IN MANY MINDS the impression exists that home-made small tools are generally not so good either in quality or durability, as those purchased outside. Often this impression is correct. However, granted good material, heat-treatment and control, there is little reason why emergency demands for form mills cannot be met at home when thorough understanding exists of the principles involved and of machine type limitations before the job is started.

It must be recognized that relieving attachments are exactly what their name says they are—merely attachments. They must not be expected to compete successfully either in range or output with the specialized universal or plain relieving lathes available from several German manufacturers.

This condition merely emphasizes the need for intelligent appreciation of the whole problem. Satisfactory work can be accomplished by the use of the commercially available relieving attachments furnished with the average toolroom lathe. So with proper understanding of the fundamentals involved and methods of their application, the making of formed milling cutters and the like need not be the forlorn hope it has so often been considered.

If a lathe tool moves in a radial path toward the axis of a workpiece being uniformly rotated, it produces on the workpiece, in the planes normal to the axis, shapes whose polar equations are of the form:

$$\rho = K - f(\theta) \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

If the motion of the lathe tool in the radial path is uniform, the shapes produced have as their equations:

$$\rho = K - a\theta \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

θ is measured in radians, and a is the shift of the lathe tool per radian rotation of the work.

These curves are Archimedean spirals.

If the tool moves uniformly in a non-radial straight line, offset from the axis by a desaxé d, the equations are:

$$\rho^2 = K^2 - 2aK\rho + a^2\rho^2 + d^2 \ldots. (3)$$

If the workpiece happens to be a formed mill being relieved, the tangents of the clearance angles with respect to tangents to the circumscribed circle at the cutting edges are:

$$\tan\gamma = \frac{a}{\rho} \text{ for the Archimedian spiral} \ldots (4)$$

and

$$\tan\gamma = \frac{a}{\rho}\sqrt{1 + \frac{d^2}{\rho^2}} \text{ for spiral of equation 3} \quad (5)$$

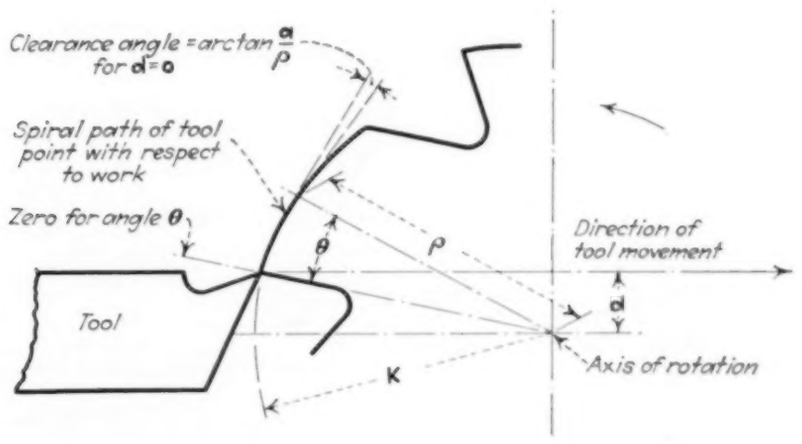

Fig. 1—Fundamental relieving spiral

When d ≠ 0, equation of the spiral is:
$\rho^2 = K^2 - 2aK\theta + a^2\theta^2 + d^2$
When d = 0, equation of the spiral is:
$\rho = K - a\theta$, provided that the angular velocity of the work and the linear velocity of the tool are both uniform.
a = shift of tool point per radian rotation of the work.

Relieving attachments directly operated may be easily arranged to produce either of the above spirals, and upon inspection it is apparent that Equation 5 reduces to Equation 4 when d is zero.

With such attachments, change of stroke is accomplished by either the use of cams of varying lifts or by deliberately limiting the travel of the tool slide by limiting retraction by the interposition of some adjustable stop.

A second type of relieving attachment changes the stroke by change of position of a rocker arm in the reciprocating mechanism or a shift of fulcrum of such rocker arm.

The general consequence of such procedure is to make the equation of the spirals produced have the general form:

$$\rho = K - a\theta - f(2n\theta) \quad \ldots\ldots (6)$$

where $f(2n\theta)$ is some sine or cosine function of θ or its even multiples.

Special cases may exist where the numerical value of the last term becomes zero, in which event Archimedean special relief may be produced for one and only one length of relieving slide stroke.

The attempt to compensate for the presence of a periodic term in the right side of Equation 6 by the device of causing the tool to move in a desaxé path will not generally be effective, especially when the stroke of the relieving slide is great. Hence the latter type of attachment, though cheap, flexible in handling and convenient, is not thoroughly well fitted for all types of relieving though satisfactory for some as will be later apparent.

In the former, directly operated type, the cams used may be either single or multilobed, depending upon number of teeth to be relieved and conditions limiting the installation of relieving change gears.

The spirals produced on the workpiece have as their equations:

$$\rho_w = r_w - A\theta \quad \ldots\ldots (7)$$

where:

$$A = \frac{N}{n} \times a_c$$

θ = angle of work rotation (radians)
N = no. of teeth to be relieved
n = no. of lobes on the cam
a_c = cam constant, rise per radian on cam
r_w = workpiece radius at cutting edge.

And the clearance angle of any radius ρ_w is:

$$\gamma = \arctan \frac{A}{\rho_w}$$

A given relieving cam will produce constant clearance angles on cutters of constant circular pitch of teeth. Conversely, cutters of constant diameter, relieved by use of the same cam, will have increasing clearance as the number of teeth increases.

Further, if diameter, number of teeth and desired clearance angle at the outside diameter of the cutter be established, then the required number of lobes on the relieving cam is fixed by change gear limitations, and the cam constant required is given by the relationship.

$$a_c = \frac{\text{No. lobes on cam} \times \text{cutter dia} \times \tan \text{clearance angle}}{2 \times \text{no. teeth to be relieved}} \quad \ldots\ldots (8)$$

Difficulty with cutters, caused by insufficient clearance, and shortness of life, caused by excess clearance, are easily understood in the light of the foregoing paragraph.

Tables I, II and III give the clearances produced by various cams of characteristics listed, for numbers of teeth per unit cutter diameter between 1 and 8.

Radial Faced Form Cutters

It is not mandatory, however, that the relieving motion occur normal to the work axis. In the general case, the direction of motion of the relieving slide will include an angle μ with the work axis, and considering a straight-line tool edge, this latter will likewise include an angle α.

Usually μ and α are measured in opposite directions, and with this proviso, we have as clearance angles:

$$\text{Radial relief} = \arctan \frac{A}{\rho_w} (\sin \mu + \cos \mu \tan \alpha) \quad (9)$$

$$\text{Axial relief} = \arctan \frac{A}{\rho_w} (\cos \mu + \sin \mu \cot \alpha) \quad \ldots\ldots (10)$$

$$\text{Normal relief} = \arctan \frac{A}{\rho_w} \sin \mu + \alpha \quad \ldots (11)$$

If the sum $\mu + \alpha = 90$ deg. the tool line is normal to the relieving motion, and we then have as clearance angles:

$$\text{Radial relief} = \arctan \frac{A}{\rho_w} \sec \alpha \quad \ldots\ldots (12)$$

$$\text{Normal relief} = \arctan \frac{A}{\rho_w} \quad \ldots\ldots (13)$$

$$\text{Axial relief} = \arctan \frac{A}{\rho_w} \csc \alpha \quad \ldots\ldots (14)$$

If the motion is normal, namely when $\mu = 90$ deg., the clearances are:

$$\text{Radial relief} = \arctan \frac{A}{\rho_w} \quad \ldots\ldots (15)$$

Table I—Radial Relief Clearance
Single-lobe cams—Archimedean spiral relief

Cam constant a_c	0.015	0.025	0.040	0.065
Cam lift $5a$	0.075	0.125	0.200	0.325

No. Teeth per in. of cutter diameter	Clearance angle			
1	1° 43′	2° 52′	4° 35′	7° 24′
1½	2° 35′	4° 18′	6° 51′	11° 02′
2	3° 26′	5° 43′	9° 05′	14° 34′
2½	4° 18′	7° 08′	11° 18′	18° 0′
3	5° 10′	8° 32′	13° 30′	21° 19′
3½	6° 0′	9° 55′	15° 38′	24° 28′
4	6° 51′	11° 18′	16° 45′	27° 29′
4½	7° 42′	12° 40′	19° 48′	.....
5	8° 32′	14° 02′	21° 50′	.....
6	10° 12′	16° 42′	25° 40′	.....
7	11° 52′	19° 16′	.....	.....
8	13° 30′	.....	.....	.....

For other ratios of number of teeth to cutter diameter:

$$\tan \text{clearance angle} = 2 \times \frac{N}{D} \times a_c$$

Table II—Radial Relief Clearance
Double-lobe cams—Archimedean spiral relief

Cam constant a_c	0.015	0.025	0.040	0.065
Can lift $5/2 \times a_c$	0.0375	0.0625	0.100	0.1625

No. Teeth per in. of cutter diameter	Clearance angle			
1	0° 51½′	1° 26′	2° 18′	3° 44′
1½	1° 17½′	2° 09′	3° 26′	5° 35′
2	1° 43′	2° 52′	4° 35′	7° 24′
2½	2° 09′	3° 35′	5° 43′	9° 14′
3	2° 35′	4° 18′	6° 51′	11° 02′
3½	3° 1′	5° 01′	7° 57′	12° 50′
4	3° 26′	5° 43′	9° 05′	14° 35′
4½	3° 52′	6° 25′	10° 12′	16° 18′
5	4° 18′	7° 7′	11° 18′	18° 15′
6	5° 10′	8° 32′	13° 30′	21° 18′
7	6° 0′	9° 55′	15° 38′	24° 28′
8	6° 51′	11° 18′	17° 45′	27° 28′

For other ratios of number of teeth to cutter diameter:

$$\tan \text{clearance angle} = \frac{N}{D} \times a_c$$

Table III—Radial Relief Clearance
Four-lobe cams—Archimedean spiral relief

Cam constant a_c	0.025	0.040	0.065
Can lift $5/4 \times a_c$	0.0312	0.050	0.0812

No. Teeth per in. of cutter diameter	Clearance angle		
1	0° 43′	1° 09′	1° 52′
1½	1° 04½′	1° 43′	2° 31′
2	1° 26′	2° 17½′	3° 44′
2½	1° 47½′	2° 54′	4° 39′
3	2° 09′	3° 26′	5° 35′
3½	2° 34′	4° 01′	6° 29′
4	2° 54′	4° 35′	7° 24′
4½	3° 14′	5° 10′	8° 18′
5	3° 35′	5° 43′	9° 14′
6	4° 18′	6° 51′	11° 02′
7	5° 01′	7° 58′	12° 48′
8	5° 43′	9° 05′	14° 34′

For other ratios of number of teeth to cutter diameter:

$$\tan \text{clearance angle} = \frac{N}{2D} \times a_c$$

$$\text{Axial relief} = \arctan \frac{A}{\rho_w} \cot \alpha \quad \ldots\ldots (16)$$

$$\text{Normal relief} = \arctan \frac{A}{\rho_w} \cos \mu \quad \ldots\ldots (17)$$

In Equations 15, 16 and 17, when $\alpha = 180 - \mu$, no relief occurs, the work being turned conical if the tool edge is a straight line. If angle μ be zero, that is, when the relieving slide is parallel to the work axis, the relief is axial and the relieved surfaces helicoidal with a lead of $2\pi A$, independent of slope of tool edge with respect to the work axis.

If curvilinear-form relieving tools are substituted for straight-line tools, the above relationships apply to tangents to such tool profiles. The general relationships are illustrated in Fig. 2.

Ability to relieve angularly is of great importance, particularly where cutters must produce profiles, parts of which are nearly normal to the cutter axis, provided the produced profile as a whole may shift axially under repeated sharpenings. The common combination center drill and countersink is a familiar example of an axially relieved tool.

While Equations 9 to 17 inclusive are built up around ability to produce Archimedean spiral relief, it must be recognized that the type of spiral produced by the relieving attachment is immaterial provided the faces of the formed cutters relieved occupy radial planes. Hence, either directly or indirectly actuated attachments may be utilized for such work.

Another use for angular relieving is in the fabrication of special cams for use with the Archimedean spiral attachment, the easy production of modified lift and a_c values occurring as now described.

For finish grinding, a small grinder is arranged on the relieving slide, with its axis parallel to the work axis, and equipped with a wheel of the same diameter as the follower roll. Using the same notation as before, cams may be ground, using existing relieving cams as masters. The characteristic of the new cams will be:

$$a_c\,(\text{new}) = \frac{\text{drivers}}{\text{followers}} \times \sin\mu \times n\,(\text{old}) \times a_c\,(\text{old})$$

and the number of lobes in the new cam $= \dfrac{\text{drivers}}{\text{followers}} \times n$ (old). Thus a_c may be reduced without increase in number of lobes, but an increase of a_c is accompanied by increase in number of lobes by this method. Usually this is no disadvantage however. The angle μ, as before, is the angle included between the work axis and the line of relieving motion.

With the advent of stiffer milling machines and particularly in milling light alloys, raked tooth milling cutters

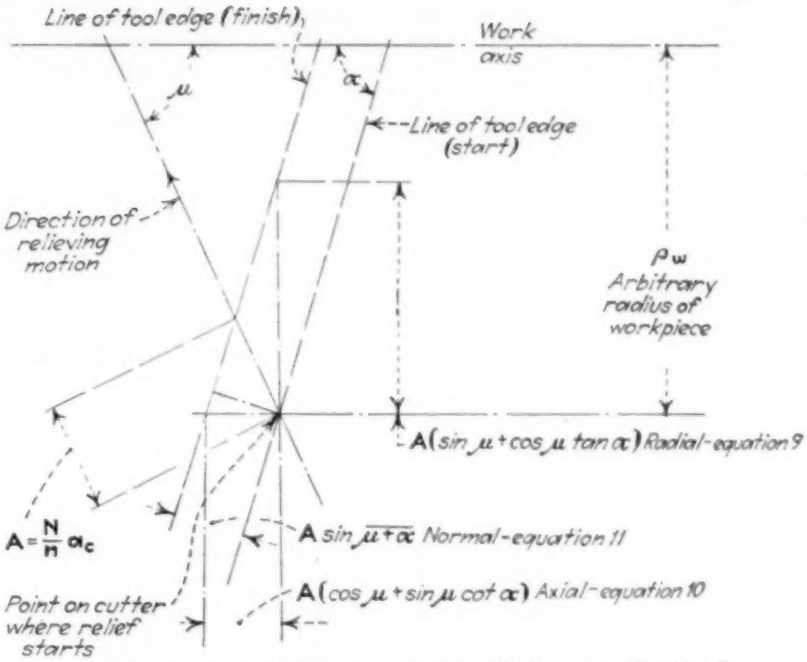
Line of tool edge (finish)
Work axis
μ
α
Line of tool edge (start)
Direction of relieving motion
ρw Arbitrary radius of workpiece
A(sin μ + cos μ tan α) Radial-equation 9
A = N/n ac
A sin (μ + α) Normal-equation 11
A(cos μ + sin μ cot α) Axial-equation 10
Point on cutter where relief starts

Fig. 2—General relations in angular relieving are illustrated by the above diagram

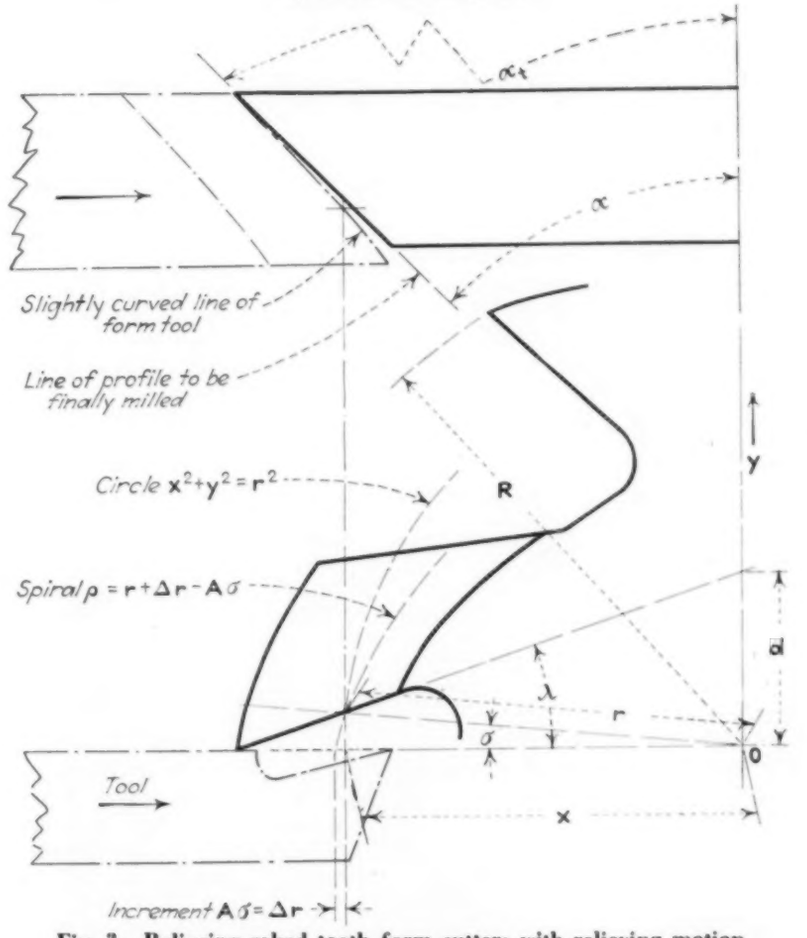

Fig. 3—Relieving raked tooth form cutters with relieving motion normal to the axis

$$x = -R\sin^2\lambda \pm \cos\lambda\sqrt{r^2 - R^2\sin^2\lambda}$$ (use the negative solution)

$$r = A\left(\arccos\frac{x}{r}\right) \qquad \alpha_1 = \operatorname{arccot}\frac{(R-r)\cot\alpha}{R - r - A\left(\arccos\frac{x}{r}\right)}$$

approximate only since line of form tool is not quite straight.

have advantages. The method herein described presupposes the use of attachments capable of Archimedean spiral relief and fails where other spiral relief is produced when accurate reproduction of profile is necessary over the useful life of the cutter being relieved.

Referring to Fig. 3, the coordinates of any point arbitrarily chosen on the cutter edge must furnish one solution to the two equations:

$$y^2 + x^2 = r^2$$
$$y = cx + d$$

the origin of coordinates being the cutter axis.

Eliminating y, we have:

$$x = -R \sin \lambda + \cos \lambda \sqrt{r^2 - R^2 \sin^2 \lambda} \quad \ldots\ldots (18)$$

where R = maximum radius of cutter
λ = rake angle at R
r = radius of an arbitrary point on the cutting edge which is likewise on the profile to be milled.

With the tool edge in the radial plane, as relieving proceeds the relieving cut at r will occur later than at R and the tool must not be made identical with the milled profile. The lag, in circular measure, is $\sigma = \arccos \frac{x}{r}$, and since the relative movement of tool and work is an Archimedean spiral, the shift of form tool shape from desired milled profile is: $\Delta r = A\sigma$ or:

$$\Delta r = A \left(\arccos \frac{x}{r}\right) \quad \ldots\ldots (19)$$

x being the solution of Equation 18.

A, appearing as a factor of the right-hand side of Equation 19, emphasizes the necessity for production of Archimedean spiral relief; and from the above equations, coordinates for formed relieving tools may be obtained.

Alternately, if parts of the profile to be produced are straight-line, the inclination of the relieving tool, compound slide or taper attachment is given approximately by:

$$a_t \cong \operatorname{arccot} \frac{(R - r) \cot a}{R - r - A \arccos \frac{x}{r}} \quad \ldots (20)$$

However, this will not give an exact profile producing cutter, for the following reasons: The polar coordinates of the arbitrarily chosen point are r and σ, interrelated as follows:

$$\frac{R}{r} = \cos\sigma + \sin\sigma \tan\lambda, \text{ from which:}$$

$$\frac{d\sigma}{dr} = \frac{R}{r^2 (\sin\sigma - \cos\sigma \tan\lambda)}$$

Since necessary modification is proportional to σ, then for the relieving tool to be straight-line $\frac{d\sigma}{dr}$ should be either zero or constant, which it is not.

Actually, the relieving tool should be convex toward the cutter being relieved, but for both small values of λ and of changes in r, the convexity is slight. Raked angle-form cutters relieved with straight-line tools will actually produce slightly concave workpieces.

Computation of point-to-point modification by Equations 18 and 19 is offered as a desirable alternative to the solution of transcendental equations for σ, of the type given immediately above.

Time Available for Relieving

With some relieving attachments, the follower always contacts the relieving cam and the slide has regular movement. The ratio of relieving to retracting time is constant, a suitable value being 5 to $2\pi - 5$. With other types, the follower contacts the cam only during relieving motion, retraction being accomplished solely by the return spring, and the rate of retraction being unmodified by any cam action.

Strictly, the displacement-time relationship during retraction is a portion of either a damped or of a dead-beat oscillation, depending upon the mass and friction of the moving parts and upon the spring characteristic.

However, to a satisfactory first approximation, the time consumed in retraction, for attachments in good mechanical condition, varies as the square root of the length of stroke as follows:

$$t_r = \frac{1}{7} \sqrt{\frac{Ws}{f}} \text{ seconds} \quad \ldots\ldots (21)$$

Where: t_r = time consumed in retraction.
W = weight of moving parts in lb.
s = stroke in inches.
f = average spring force at mid-stroke.

Thus, unsnubbed retraction is accomplished in minimum time for a given mass, stroke and spring combination, and since this time is independent of the frequency of relieving strokes, it follows that narrower and narrower gashes may be "gotten out of" merely by progressively reducing the number of teeth relieved per minute, as the lower this frequency the greater the ratio of relieving to retracting time.

When maximum life of cutter is not limited by necessity for much chip room, as in the case of the milling of light cuts in cast iron, this type of attachment will permit of making longer lived (potentially) cutters than will the other type.

Unfortunately, the condition of unsnubbed retraction involves the utilization of a drop-off type of cam, which is irreversible, and the direction of rotation of the lathe cannot be altered without jamming the mechanism. Reversibility is an essential in some work.

The somewhat alarming thump that occurs in the use of the drop-off-cam type of relieving attachment is really nothing to worry about. The absorption of the kinetic energy of the slide subjects the cam and its supporting bearings to shock loading, but the shape of the cam is such that little if any torque shock is fed back into the driving system.

When using forming tools, the most sudden demand on the driver occurs at the beginning of cutting, as in radial-faced cutter making where the whole width of tool comes immediately into action. With the raked-faced cutters, the rate of change of torque demand is obviously less abrupt because of the time lag occasioned by the rake itself. No noise is produced at this stage, however, so the shop man does not think of this as a trouble maker.

The shape of the heel of the tooth, for proper backing up and chip room, again, is generally conducive to gentler changes in or reductions of driving torque. As the tool breaks out into the gash and retraction begins, the torque demand is zero, and in the case of the controlled return type, may even be slightly negative at times.

Shock loading in torque is the fundamental cause of most drive troubles, and it is accentuated by slack in splines, feather keys and universal joints where these occur in the mechanism. The chief precautions to observe are to see that the change gear brackets are tightly secured, using positive rather than frictional means where necessary.

Again the position of the change gear quadrant, or banjo plate should be such that should it loosen, it will not gather in and, acting as a toggle joint, cause breakage of the lathe. The writer knows of at least one commercial attachment, erroneously designed, which to use successfully recourse had to be taken to key-locating the change gear quadrant.

Where universal joints are used in the drive, they should naturally be properly phased, and attention paid to the little recognized fact that the presence of universal joints in a drive transmitting torque introduces periodic bending into the connected shafts. The maximum and minimum values of this bending movement are equal and opposite in sense, proportional to the torque transmitted and to the sine of the angle included by the axes of the inclined shafts.

Freedom from binding when testing by hand during set-up is no guarantee that it will not occur under load, so that care should be taken adequately to support sliding shafts incorporating universal joint drives at their ends, particularly when relieving long slender pieces. These things having been attended to, there is remote likelihood of mechanical trouble developing from any cause other than excess speed.

Welded Tubing for Automobile Use

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AUTOMOTIVE parts makers, accustomed to using seamless tubing for such parts as torque tubes, rear axle housings, cross shaft tubes and tire carriers, have discovered that the use of fabricated carbon arc welded tubing for these purposes is resulting in distinct economies in manufacture. Not only are the carbon arc welded tubes stronger, lighter and of a uniform wall thickness but shop costs have been materially reduced.

By the older method it was customary to use seamless tubing of a uniform diameter. The necessary taper was produced by swaging, which resulted in a thicker wall at the small end where it was undesirable. Costs were high, not only for material but for equipment and labor.

Carbon arc welding is now being used in the plant of the American Metal Products Company at Detroit to produce tubing from strip steel stock. This method permits of the use of lighter weight material with uniform wall thickness and adequate strength where it is needed.

Fourteen Electronic Tornado automatic arc welders, using the "Shielded Arc" process manufactured by the company with whom the writer is connected are in use here. With this equipment the plant has a capacity of 20,000 tubes a day. In addition to tubing for the purposes mentioned here numerous special purpose tubes in smaller quantities are made.

The panel board of Fig. 1 shows the progressive steps in the manufacture of a tire carrier tube. The original wall thickness is 0.093 in. and the turned up flange on the ends has a thickness of approximately 0.250 in. These tubes have been upset to 3/8 in.—the equivalent of thickening the walls four times—without splitting the weld.

The saving in material cost runs from 10 to 50 per cent, depending upon the analysis of the steel and type of tube. There is a saving in weight because the fabricated tube can be designed to have the proper weight at the right place. Since swaging is unnecessary to produce the taper, excess material does not have to be put into the tube to swage it down later. Tubes of special dimensions and tapered tubes are fabricated so that the tube is finished when it comes from the welding machine.

Each welding head is mounted on a 14-ft. beam and driven by a standard Lincoln carriage. The beam is mounted over a table holding the fixture in which the tubes are inserted on mandrels, as shown in Fig. 2. Depending upon length, from two to four tubes are welded in line, and at the rate of approximately 40 in. per min. This speed can be increased materially.

Floor to floor production is dependent upon the length and thickness of tubing. An average of 1,000 tubes an hour—based on a 20-hr. day—can be maintained. Tubes in this plant are made in lengths from 14 to 50 in. and from 0.0093 to 0.0375 in. wall thickness.

Fig. 1—Progressive steps in fabricating a tire carrier tube

Fig. 2—Automatic arc welding equipment used in making tubes

How to Buy Machine Tools—III

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Keeping informed on the latest developments and on the state of installed machinery. Replacement formulas and modernization policies and budgets

EACH machine tool user should have some sort of a plan for replacing obsolete equipment. He may not realize it but equipment must be replaced either because it wears out or because it is superseded by machinery that will produce at a much lower cost. The old method was to wait until the machine wore out, or until attention was called to the machine forcibly by the increased cost of production, before any action was taken on replacement. Since shop supervision tries to eliminate as many of its troubles as possible the machine that is continually causing annoyance by breakdowns, inaccurate work and inefficient operation, is the subject of replacement request whether it is obsolete or not.

Machine tools are the most important asset that any manufacturer may have. Without them it would be practically impossible to do the things that have been done since their invention. Some of the best mechanical engineers are to be found in the machine tool industry, and they are continually making improvements in the machine tool so that it will perform more efficiently in all respects than the ones already in use. Under such conditions, the machine tool user should take full advantage of the additional improvements.

It is difficult, of course, to do this without some definite plan of action. In the first place, it is necessary to be familiar at all times with the improvements that are being made in machine tools. This can be done either by visiting the various machine tool manufacturers or having the machine tool manufacturers' representatives visit the users' shops. The technical magazines, advertising literature, catalogs, etc., contribute materially to keeping the users informed on what is being developed. The machine tool industry is so organized today that it should not be difficult to obtain information on the latest machines.

To take full advantage of the accomplishments of the industry the user should also devise some definite means of periodically investigating his present equipment so that any inefficient or obsolete machine tools can be replaced as soon as they are superseded by more modern equipment. Then a definite plan to replace the obsolete machines in an orderly fashion should be adopted.

Most users of machine tools keep a record of the date of purchase of all machines; also a brief description of the machine cost, installation cost, electrical equipment required, etc. From this record can be determined the age of the various machine tools as a guide to those that should be investigated for replacement. Certain statistics indicate that a machine tool more than ten years old is usually superseded by a machine of far superior quality and capacity for production. Then we can prepare a list of all machine tools in the shop that are more than ten years old. Each machine should be visited and a careful analysis made of the work it is performing as to cost, quality, the fatigue factor to the operator, handling to and from the machine, etc. This performance can be compared with that of a modern machine and a decision made as to whether it would be economical to replace the old one.

After all these machines are surveyed, a definite plan should be laid out giving consideration to the time required to justify the investment. Several plans have been suggested along this line, some of them advocating three years, others five years. A three-year plan is much more desirable because so many changes take place, not only in the machine tool but also in the product that is being machined, that replacement should not be extended over too long a period. Each year a certain number of machines should be purchased to replace the obsolete ones. In this way a schedule can be followed which will eliminate the delay in delivery that is likely to be encountered in busy years. At such times, if the demands are very high, the machine tool manufacturer has difficulty meeting the requirements without additional facilities. If all these replacements take place during the busy years and none during the years of least activity, it is impossible to get good service when times are good and it is not exactly fair to the machine tool manufacturer during the lean years. A plan of this kind would help considerably in smoothing out the peaks and valleys in the business curve.

Replacement Formulas

Many formulas have been submitted on replacement of machine tools. Some of them are very complicated and for this reason I do not believe are often used. It is advisable to make the replacement formula as simple as possible and determine the time that should be required to pay for a machine. Under ordinary circumstances, four years seems to be the average time to pay for a machine from the savings obtained from it because of its greater efficiency. A very simple formula under these conditions is as follows:

$$x = \frac{a + b - c - d}{g\ (e - f)}$$

Where:

a=cost of new machine

b=balance of depreciation on old machine

c=annual cost of maintenance

d=cost of overhauling machine

e=present cost of product per piece

f=estimated cost of product on new machine

g=activity per year in per cent

x=number of years to pay for the machine

There naturally are other charges that should be considered, such as depreciation, interest, etc., but if x is kept sufficiently low. it will more than offset any additional charges that could be included.

The length of time in which a machine should pay for itself is a variable factor which depends primarily upon the kind of product that is being manufactured. It can readily be appreciated that where the design of product is seasonal or changes every year any new equipment especially if it be adapted

only to a particular operation should pay for itself within the duration of the design which in this particular case will be one year. The average life of a design I believe is considered to be approximately five years. Therefore for the majority of equipment purchased, it can be safely assumed that if it pays for itself within four years it is a good investment. Then again we have very large work where the design does not change radically and where extremely larg equipment is necessary so that it is very difficult to justify any of the new equipment on a savings basis within the time specified above. These partcular cases are special; however, some length of time should be set up as a guide. Certain manufacturing concerns have assumed ten years as being proper for justifying large equipment.

Good Judgment Vital

Regardless of what plans may be set up for controlling any expenditures for new tools. good judgment must always be used. There are so many variable factors usually to be considered, and so many angles from which to approach the problem, that it requires some one familiar with machine tool equipment to apply any principles of this kind accurately.

There are undoubtedly many plans for budgeting expenditures for new equipment. All large manufacturing concerns have some means of providing money for these expenditures. Many of them allow appropriations for a certain period, such as three months, six months, or one year during which time the money allowed is spent for new equipment. Usually the shop submits to the management its requirements for a certain period and the management allows sufficient money to purchase such equipment as will justify itself within a reasonable time or is absolutely necessary for other reasons.

Many of these plans entail considerable work in preparing the information and submitting it to the management. Much of this work is wasted because many of the items submitted are not approved and must be requested over again, which entails additional work.

Each concern must charge to its production cost a certain amount of depreciation of the equipment, which means that the product must pay for the equipment within a reasonable length of time. This depends upon the product being manufactured and the stability of the design. Where the equipment required is more or less special for the product, and where the design of the product is changed in a short time, it is desirable to have the costs absorbed in the depreciation of the machine tools within the life of the design of the product. However, there are so many different methods of depreciation that it is highly desirable to adopt some standard that will be suitable for the majority of industry.

Several national associations have determined on such a depreciation charge. Some have set fifteen years as the time in which to write off capital charges. Others have set ten years. Still others apparently do not charge any depreciation at all, which means that when their equipment is worn out replacements will have to be financed from additional capital.

It is also important to build up a reserve fund from the depreciation charges. If equipment is properly purchased and if the proper depreciation charges are set up, it is possible to build up a reserve fund from the depreciation to be used when exceptional requiremnts are demanded from the shop. This reserve can usually be built up when business is running below normal. Then when business is increasing it is possible to take care of additional equipments, minor expansions, etc., from this reserve without the necessity of refinancing or recapitalizing.

If a budget plan based on the activity of the shop were adopted, it would tend to keep the shop modern and at the same time distribute more evenly the purchase of machine tool equipment. A budget could be made up whereby if the shop were operating 100 per cent, the entire depreciation charge should be spent for new equipment. If business were below normal, a certain percentage of this depreciation would be spent depending upon the percentage of activity in the shop. For example, if the shop were 80 per cent active, then 80 per cent of the depreciation amount should be spent, or if the shop 50 per cent active, probably 35 per cent of the depreciation amount should be spent, etc.

Annual Budget Estimates

Once a year when the shop is requesting equipment it should inform the management what activity to expect for the coming year. Based on this activity, the management could decide the amount of money that this department should spend for new equipment, the head of the department would be advised of the amount, and he would request the purchase of equipment not to exceed the amount allowed by the management. This would put the responsibility entirely up to the head of that department to purchase such equipment as would do him the most good. I believe this set-up would require less work to administer than many of the methods that are now used in industry. Also, a definite plan would be used whereby expenditures would be made in line with depreciation charges, and under these conditions it should be possible to maintain efficient modern equipment. It would also have a tendency to eliminate excessive expenditures when busins is good and no expenditures when business is bad, thereby smoothing out the business curve to a great extent.

This particular plan is submitted to take care of replacements and minor expansions necessary in the manufacturing concern. It is not intended that this should take care of any extraordinary expansions or provide funds for new activities. These particular items should be taken care of by special appropriations and financed through increased capitalization or increased funds whereever they may be obtained. Large expansions may be necessary when business is growing and it is desirable for the manufacturing industry to expand facilities to take care of increased load or to manufacture an entirely new product.

Study Expansion Needs

Before any expansions are financed, a thorough analysis should be made of the need for such expansions. If it is due to increased business, it should be determined whether this increase is temporary or whether it is permanent. Often, when a manufacturing industry has increased demands upon its production requirements that would indicate the necessity for expansion, an analysis will show that the need is only temporary, and that after a short period, the demands drop off considerably. Therefore, no expansion should take place until it is determined as definitely as possible that the increased demands will continue for a considerable period.

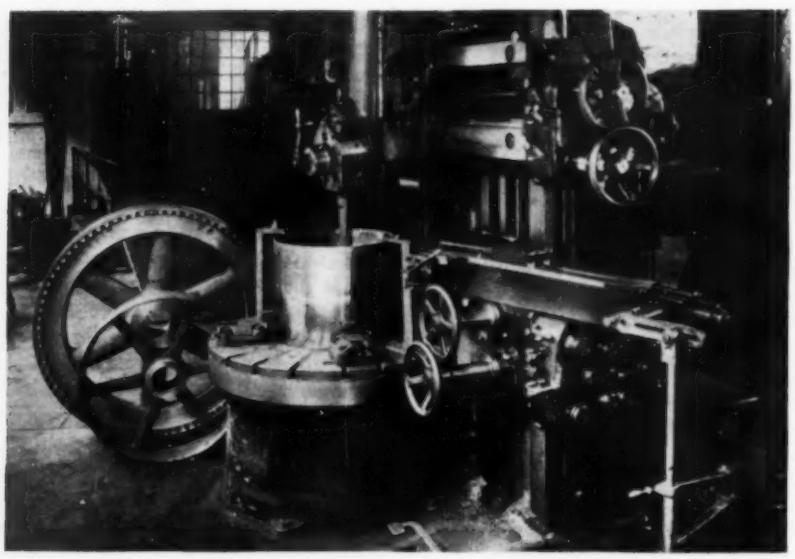
Increased facilities are also necessary when it seems desirable to manufacture a new line of product. This question should also be thoroughly investigated to be sure that there is sufficient business to maintain another supplier. Usually when a new product is put on the market, if it has quite a demand, many companies will start manufacturing a similar product. The result is that considerable investment is necessary and the business will be shared by a number of manufacturing concerns, the result being that none of them makes a profit sufficient to justify the expenditure for all the facilities that are necessary. All these things must be analyzed and good business judgment used before allowing any appropriations for the expenditure for added facilities.

[*Last of three articles. The first was published four weeks ago, the second a fortnight ago.*]

Swedish Semi-Diesel Manufacture

A. E. FRISTEDT
Stockholm, Sweden

After roughing on a planer, the baseplate of this 2-cylinder, 50-hp. marine diesel is ground to eliminate filing and scraping. A Schmolz surface grinder is employed, and ten Swedish make alundum blocks, equivalent to 16 M Norton scale, make up the wheel. No clamps are needed



For turning convex surfaces on pulleys an automatic device is fitted to a Schiess-Defries boring mill. To the left is a 2-ton flywheel 1400 mm. (53 in.) in diameter, also machined on this mill. Widia tools are used at 75 meters (246 ft.) per min.

NORMALLY over 100,000 hp. per year in semi-diesel engines is exported from Sweden. At least twenty firms are engaged in the manufacture of this product.

Small-lot production is the rule, but a few plants by standardizing parts for a number of sizes have been able to employ more specialized methods. Small engines are made in lots up to 100 at a time, but the largest ones are built singly. Shops range in size from 25 to 600 men.

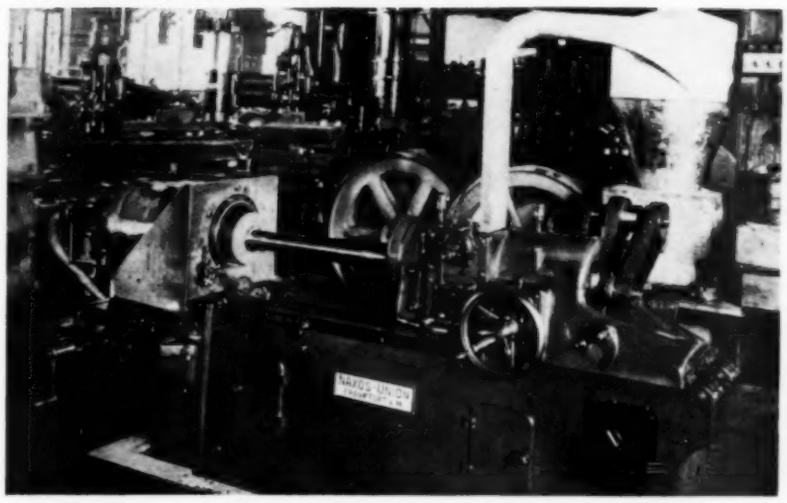
Although there is considerable variation in semi-diesel design, all such engines operate on the solid injection principle. One, two and four cylinders are used, bores ranging in diameter from 120 to 420 mm. Larger engines are directly reversible, but the intermediate and smaller sizes are equipped with friction clutch and reversing propeller blades or reversing gear and cast propeller.

A hundred per cent inspection from raw material to finished units is enforced in most plants. As a rule all parts are interchangeable. Before leaving the plant, each engine is given a work test for efficiency and fuel consumption.

Much research work is conducted to develop better materials. Semi-steel is not used for the castings since the charcoal iron available has similar characteristics and is just as strong.

As a rule shop methods are up to date, and many tools of original design are employed. Cobalt high-speed steel is used for machining forgings and bar steel, while for cast iron, tungsten-carbide has been adopted to a great extent.

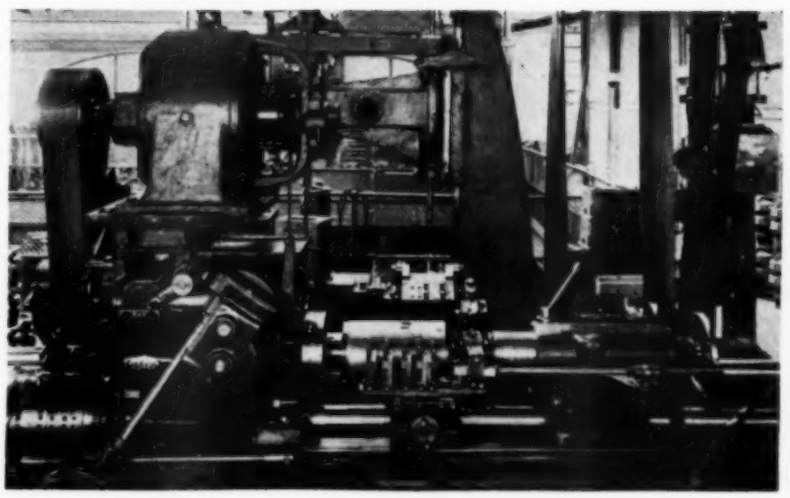
(Continued on page 148)

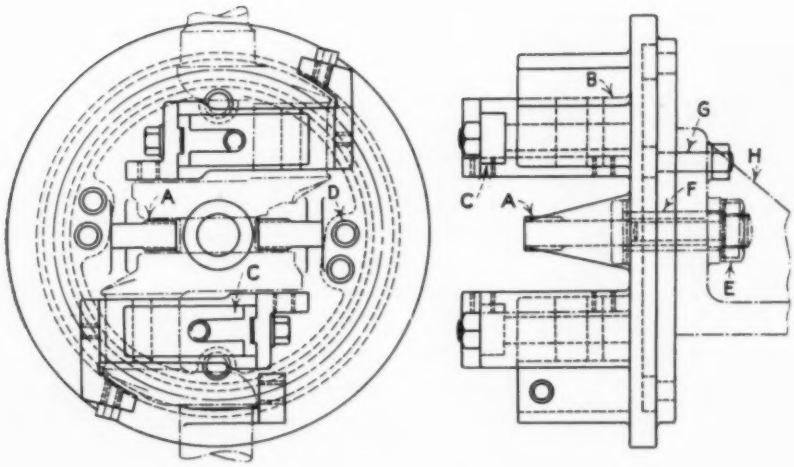


Cylinder grinding is done on a Naxos-Union planetary type machine. Although comparatively coarse, a 24 G (Norton scale) wheel produces a mirror-like finish. Dust is carried away through an exhaust pipe

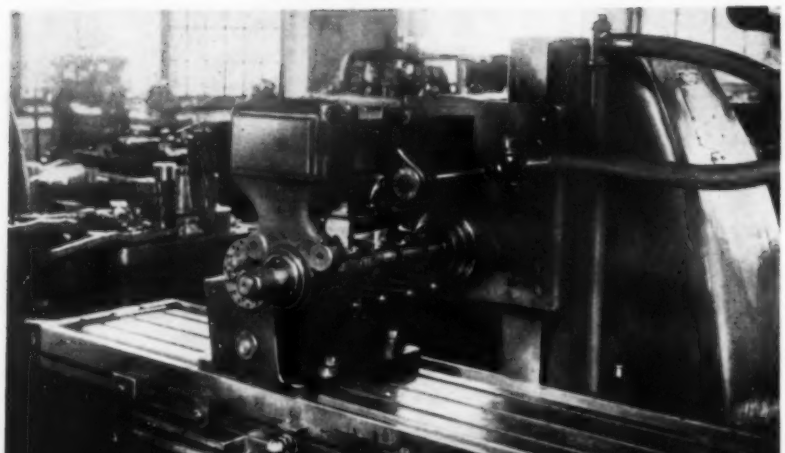
Mounted between centers, the connecting rods are machined on a Sundstrand Rigidmil. Two cuts are taken on each side, the rods being rotated 180 deg. between cuts

Piston outside diameter and grooves are rough turned on a Fay automatic. The same machine is used for finish turning





For drilling, small 2-throw countershafts are placed in the swiveling fixture, located at the bracket *A* and resting on V-blocks *B*. Clamps *C* hold the shaft. Six hardened bushings *D* and indexing pin *E* locate the swiveling plate in various positions around bolt *F*. T-bolts *G* lock the swivel against bracket *H*



Hot bulb plugs are milled on a 4-spindle indexing fixture equipped with draw-in collets. Time per piece is now 8 min. as against the 40 min. it formerly took to mill them one at a time

Boring, drilling, counterboring, countersinking and tapping the fuel pump housing are done on a homemade boring fixture. To the left is a set of tools used

Swedish Semi-Diesel Manufacture

(Continued from page 140)

It was first planned to grind the base plate from the rough, but the castings came from the foundry so irregular that they were planed first. On castings as large as these it was found that only about ☆ in. could be economically removed by grinding. After this operation, the surface resting on the parallels is planed since the shape of the work precludes grinding this side.

Stud holes are then drilled and tapped on a Raboma rapid radial. Studs and caps are hand fitted, and then the main bearings are bored on a horizontal mill.

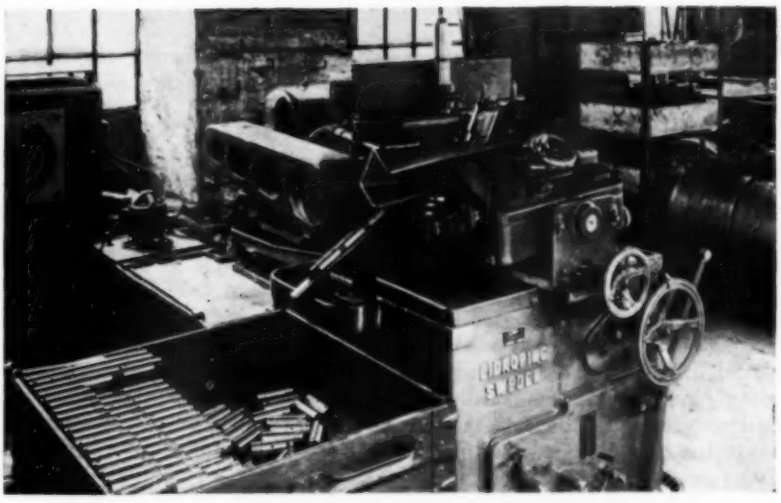
Medium-sized cylinders are bored in vertical turret lathes to avoid sagging of the boring bar. Because of the fine-grained iron used, the cylinders are quite hard and must be machined with care.

Drilling and tapping stud holes in the port flanges is the next operation. Box jigs are used for the smaller sizes and flange jigs for the larger. Then the cylinders are ground in the bracket fixture as illustrated.

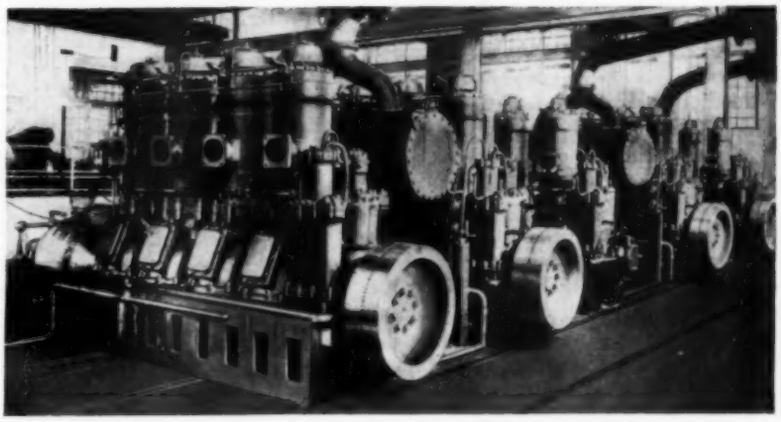
After the connecting rods have been slabbed off as shown, slots 25 mm. (1 in.) wide and 10 mm. (0.4 in.) deep are cut across the feet for locating the bronze bearings which are fitted later. The hole in the upper end is then roughed out and the cap sawed off after drilling the cap stud holes.

Forged countershafts are first planed at both sides of the crank, and then the crank is hogged out on a heavy-duty vertical shaper using two tools. The shafts are centered at both ends and then rough turned in an engine lathe. The crank pin and checks are rough turned in a Moll crankpin lathe, and the crank is drilled and tapped for counterweight studs. Larger shafts are finish turned to close limits while the smaller ones have stock left for grinding. The fixture for drilling oil holes in small two-throw shafts is illustrated.

Several other interesting steps on the main parts of these engines are also shown.



By standardizing parts for several sizes of engines, production methods can be utilized. Crank pins of drawn steel tubing are centerless ground in lots of 500 to 1000



Four 400-hp. diesels are shown on the test floor at one time. After testing each engine is disassembled and cleaned before shipping

Modern Motor Methods

IV. Crankshafts

FRED H. COLVIN
Editor, American Machinist

MANUFACTURING methods vary widely when it comes to motor crankshafts. As in the making of other parts, both the design and the ideas of the engineers as to the amount of finish necessary on non-bearing points, affect the methods employed to a considerable extent. In all cases, however, one can hardly fail to be impressed with the care taken even where the crankshaft goes into a motor that powers a low-priced car.

Four types of machines are used in crankshaft work: lathes, milling machines, grinders and drilling machines. The wide variation in practice can be seen by glancing at Tables I, II, III and IV. All four of the concerns whose methods were analyzed use lathes, grinders and drills of various kinds to about an equal extent. When it comes to milling, however, both *B* and *C* have but two milling operations each while *A* and *D* have 12 and 7 operations respectively. Much of the difference in the use of milling can probably be traced to the designs of the crankshafts.

In all the shops studied the effective work of machining begins with the center bearing, in some cases before the ends have been centered. In two instances these bearings are rough turned while in the other two they are rough ground. These bearings are used in steadying the crankshaft during the later operations. The rough machining of the center bearing precedes the drilling of the centers in three instances, centering being the fifth operation in two cases.

For convenience in making comparisons, the work has been divided among the four types of machines already mentioned, the tables showing lathe, milling, grinding and drilling machine work respectively. Crankshaft lathes are used in all the shops mentioned. In some, the work of turning the main bearings and facing the cheeks is done in a single operation. In others, the crankshafts are turned on simpler machines that require more set-ups. The difference in this practice is clearly seen by noting the number of operations credited to facing the cheeks and turning the crankpins in Table I. In one instance, the three main bearings are machined separately while in the other there are seven operations. When it comes to crankpins, makers *A* and *B* each have three turning operations, *C* has five, while *D* has but one. This means that *D* rough turns all pins at once and then finishes by using grinding operations on the different bearings.

The varying sequence of similar operations is also of interest as in the previous studies. But, with the exception of maker *A*, the main roughing operations are fairly uniform, as in Table I. The difference in elapsed time between roughing and finish turning the main and pin bearings is noticeable. In *A*, only one operation, rough grinding the thrust bearing, comes between rough and finish turning. In both *B* and *C*, seventeen and eighteen operations come in between, most of these being grinding operations.

Milling operations show great variations as to both use and sequence. The use of bolted-on counterweights gives good opportunity for milling the seats for the weights, as well as the weights themselves. Some designs of crankshaft also lend themselves to the milling of the cheek, or web, faces, both for uniformity of weight and for clearance. Milling shafts to length gets a fifty per cent mark, as does milling of locating spots to insure proper positioning in the fixtures. Keyway milling is of course universal, but aside from the operations mentioned, there is little uniformity in practice. Only one of the four shops mills the thread at the end of the shaft, while others use a diehead.

Grinding operations are perhaps more

TABLE I—Crankshafts—Lathe Operations

	A	B	C	D
R — turn center bearings	5	1	..	2
F — turn center bearings	9	..	21	..
R — face cheeks bearings	5	1-2-3	3-5-6-7-8-9-10	2
F — face cheeks bearings	..	..	16-22	..
R — turn front end	7	2	3	2
F — turn front end	9	..	21	8
R — turn rear end	7	3	4	2
F — turn rear end	9	..	21	..
R — turn crank pins	10-11-12	10-11-12	6-7-8-9-10	9
F — turn crank pins	15	..	24	12
R — turn balancer seat	7	..	..	..
F — turn balancer seat	9	..	..	..
F — turn thread diameter	..	31	..	..
F — turn flange end	34	34	4	18
Thread end of shaft	36	36	..	..
Face to length	33	31	15	10
Turn contours	..	..	12	..

TABLE II—Crankshafts—Milling Operations

	A	B	C	D
Mill shaft to length	1	4	..	..
Mill locating spots	13	..	..	4
R-mill balancer seats	16	..	..	..
F-mill balancer seats	46	..	..	..
R-mill for weight pads	17-18-19-20	..	..	..
F-mill for weight pads	17-18-19-20	..	..	..
Mill cheek faces	..	..	25	16-17-22-23
Mill cheek clearance	..	..	..	32
Mill lock fit	21	..	..	..
Mill balancer clearance	22	..	..	..
Mill keyway for gear	56	35	47	56
Mill thread on end	58	..	..	..

TABLE III—Crankshafts—Grinding Operations

	A	B	C	D
Spot grind center bearing	..	..	1-2	1
Rough grind thrust bearing	8	..	..	..
Finish grind thrust bearing	36	..	..	..
Rough grind front bearing	..	8	18	..
Rough grind rear bearing	..	10	20	6
Rough grind center bearings	..	7	17	7
Rough grind gear fit	53	9	19	..
Finish grind gear fit	..	29	40	..
Semi-finish front bearing	12	..	..	35
Semi-finish rear bearing	12	..	..	33
Semi-finish center bearing	11	..	..	34
Finish front bearing	39	30	39	51
Finish rear bearing	40	31	38	50
Finish center bearings	37-38	28	34 to 37	49
Rough grind crankpins	..	17-18-19	..	..
Semi-finish crankpins	..	..	45	13
Finish crankpins	42	25-26-27	45	48
Finish end flange	51	32	41	53
Rough lap main bearings	61	..	..	..
Finish lap main bearings	61	..	..	68
Rough lap crankpins	61	..	..	..
Finish lap crankpins	61	..	..	68

TABLE IV—Crankshafts—Drilling Operations

	A	B	C	D
Center both ends	2	5	5	3
Re-center	..	..	15	11-32
Drill locating hole	..	15	11	..
Ream locating hole	..	..	11	..
Drill crankpins	..	..	..	19-20
Drill main bearings	..	..	..	24-25
Drill oil holes in pins	32	20-21-22	28-29-30	39-41
Drill oil holes in bearings	32	..	27	27
Drill oil holes in webs	31	..	27	41-42
Drill clutch pilot hole	47	..	42	..
Drill holes for balance weights	24-25-26-27	..	26	36-38
Ream holes for balance weights	28	..	..	..
Tap holes for balance weights	28	..	26	..
Drill flange holes	54	38	43	56-57
Ream flange holes	..	38	..	58
Drill holes for balance	..	41	..	67

TABLE V—Balancing, Straightening and Inspection

Maker	Balance	Straighten	Inspect
A	2	3-6-10 15-35-41 43-63	6-14-24
B	40	6-14-24	43
C	50-64	14-33-44 52-62	50-64
D	66	70	14-35 47-71

uniform than any of the others, at least, as to the method of machining if not in sequence. All bearings are finished ground, some depending on finish turning to make a preliminary grinding operation unnecessary. Rough grinding, semi-finish and finish grinding all have their place. Two of the makers use a lapping process to finish the bearings. Still others polish with abrasive cloth, but this is not counted as a lapping operation. The grinding machine has come to play a most important part in the making of crankshafts, and uniformity as to diameter, roundness and quality of surface has much to do with the greatly increased life of motor bearings.

Drilling operations depend much on the design of the crankshaft. In the design is involved the type of oiling system used, for this affects drilling operations to a marked degree. In some designs, the crankpins are drilled lengthwise to form an oil reservoir as well as to lighten the shaft. The ends are frequently closed with Welch plugs. The oil holes that carry lubricant to the bearings are drilled to meet this central hole and also through the web or cheek of the shaft to the main bearings. Others have no central hole or cavity.

Much ingenious machinery has been devised for the drilling of these holes, some of the more recent having a number of motor-driven spindles set at the proper angles for the crankshaft to be drilled. Such rapid drilling methods have made it possible to use force feed lubrication in low-priced cars, where the old methods of drilling would have been too costly.

Straightening, balancing and inspection are all important operations on crankshafts, the first two being peculiar to this part of the motor. Inspection also comes at frequent intervals to check both dimensions, straightness and balance. The importance of these operations is emphasized by Table V.

This table does not, however, tell the whole story, as in many cases the final balancing is done after the flywheel is attached to the crankshaft as part of the assembling operation and not appearing in the list of manufacturing operations. Likewise, each balancing operation includes an inspection so far as balance goes.

Straightening and Balancing

There is a striking difference in the number of straightening operations, varying from one to eight. In some cases, the straightening of each bearing is a separate operation, which accounts for the number. In another shop, the straightening of the whole shaft is one of the last operations. Balancing is also well along in the list of operations, the mass balancing of *A* in the second operation being different from all the rest. The final balancing is done after assembly with the flywheel and clutch. This is also done on other motors.

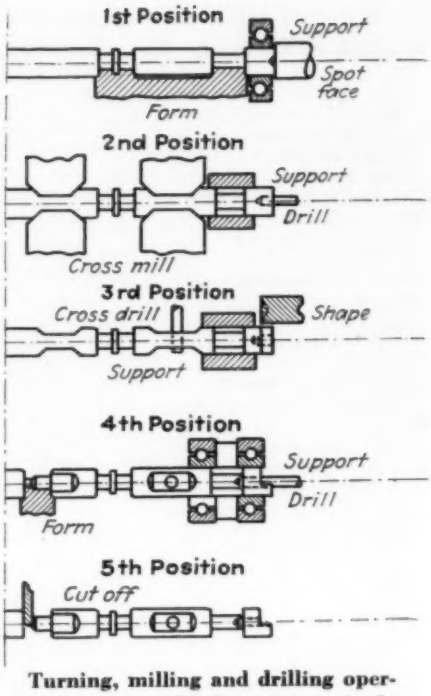
The crankshaft, perhaps more than any other major part, shows extremely wide variations in practice, especially in the use of milling machines. Given crankshafts of similar design, it is likely that the sequence of operations adopted in different plants would vary but little. Then, too, there is the question of quantity, of frequent change in either design or output, which directly affects the kind of machine to be employed. This does not refer so much to whether machine is a lathe or grinder as to the extent to which it is made automatic. The experience of the past few years, with greatly decreased production and more frequent changes in design, has naturally led to the use of more simple machines instead of combining several operations, as was the tendency a few years ago. Special attachments or fixtures for use on standard machines seem to be growing in favor.

Automatic Operations On a Small Shaft

H. T. SMITH

Engineer, The National Acme Company

All steps in machining a windshield wiper shaft were combined and the time cycle reduced to 6 seconds

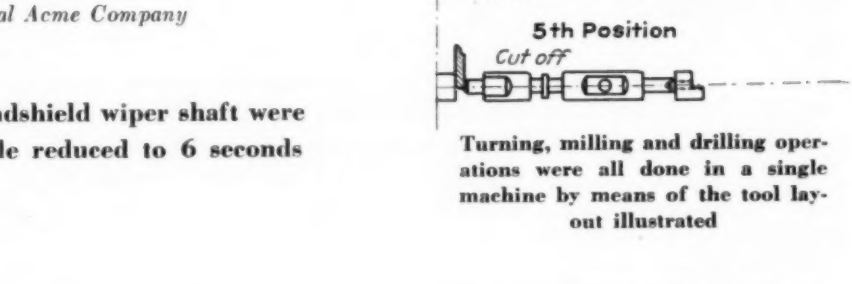


Turning, milling and drilling operations were all done in a single machine by means of the tool layout illustrated

PARTS having accurately located cross-drilled holes or milled sections often are difficult to make on a production basis. The 2½-in. automobile windshield wiper shafts for which the special tooling is described were formerly produced on five separate machines. The 0.125-in. and 0.195-in. diameters and the 0.085—0.086-in. hole were formed and drilled in a small single spindle automatic lathe, the milling was done on three separate milling machines and the cross-drilling on a drill press.

This plan was satisfactory until production was stepped up several thousand pieces per day. One of two things then had to be done. Either more lathes, milling machines and drill presses had to be bought, or the operations had to be performed on a single multiple-spindle high-speed machine.

A $\frac{9}{16}$-in. capacity five-spindle automatic screw machine capable of producing around 600 pieces per hour was chosen because of its open construction and the ease with which the special cross-milling attachments could be mounted. Since the machine had an anti-friction spindle bearing, an ingenious arrangement for stopping the work spindles in any or all positions was accomplished by using the disk clutches on the work spindles at the rear of the front spindle bearings. These clutches are actuated by a stationary cam attached to the inside of the headstock section of the machine. As the work spindle carrier is indexed, the spindles are stopped as required. Whenever a cross-drilling or cross-milling operation is performed the work spindle must be stopped.



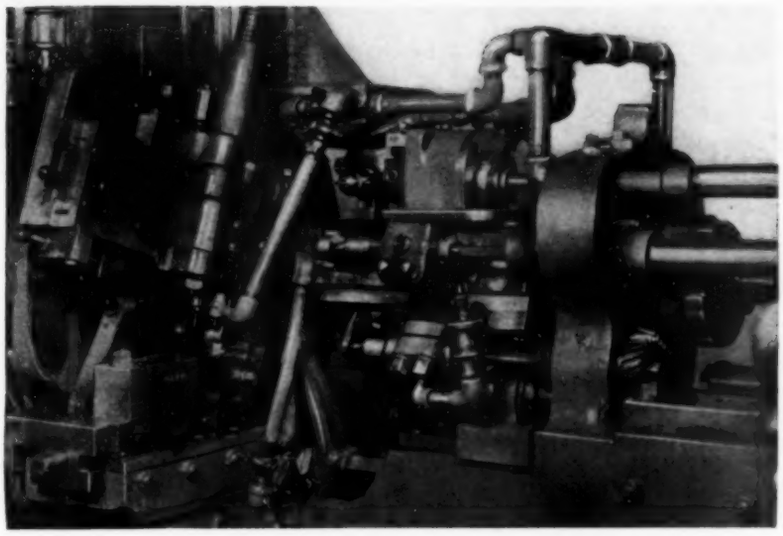
A detail of the paddle shaft shows the number of surfaces to be machined and the precision required

By combining most of the operations on the first three positions or stations it was possible practically to finish the shaft before forming the 0.124-in. diameter. In this way the stock was not weakened and more production could be obtained by using greater feeds.

The sequence of operations and the tooling used are as follows, starting in the first position, that is, the lower front station:

1. The three 0.125-in. diameters and the 0.195-in. diameter are formed with a dovetail forming tool while the work is supported in a ball-bearing rest located on the toolslide. The 0.085—0.086-in. hole is also centered and the part faced to length with a combination spotting and facing tool carried in a rotating high-speed drilling attachment.

2. The work spindle carrier indexes the work to the second position where the spindle is stopped while the cross-milling attachment, held in a special side slide, feeds across the work. The two sets of butt-mills mill the four flat portions with the 45-deg. angles at their ends. This attachment is independently motor-driven through the cable shown in the photograph. While the milling is being accomplished, the work is supported from the toolslide and the 0.085—0.086-in hole is drilled half way with a rotating high-speed drilling attachment.



A five-station automatic does work formerly requiring five separate machines

3. The work spindle carrier, advancing the work to the third position, keeps the work spindle stopped and locked in position for drilling the 0.124—0.126-in. hole, at right angles to the central milled flats. This cross-drilling attachment is also driven direct with a small motor and is advanced by a cam on the rear cross-slide cam disk. In this same station a support is used on the toolslide and a special shaping attachment mounted on the toolslide shapes the 0.125-in. section off 0.012-in. below center. This type of attachment was used because a square shoulder at the termination of the shaped section was required. The attachment carries a tool similar to that used on a shaper and is actuated across the work by a rotating cam while being advanced into the work longitudinally by the toolslide cam.

4. As the carrier indexes to the fourth position the work spindle is unlocked and starts to rotate for forming the 0.124-in. diameter. A flat-type forming tool is held in a tool post mounted on the rear cross-slide. A double ball-bearing support is used on the toolslide to steady the work for drilling the other half of the 0.085—0.086-in. hole. This drilling is again accomplished with a rotating high-speed attachment. The high-speed drilling attachments used in the first, second and third positions and the special shaping attachment are driven directly from the standard center idler drive gear shown in the photograph just back of the center main-frame section. This idler gear is in turn driven from the gear box section of the machine through a shaft located in the second position.

5. The fifth position is used for cutting off the work and feeding out the stock for the succeeding piece. The stock stop is shown in the photograph in the retarded position ready for the tools to advance to the work.

Making and Keeping Crankpins Square

Discussion

C. G. WILLIAMS
Consulting Mechanical Engineer

It seems good to see again the name of F. M. A'Hearn (*AM*—Vol. 76 page 827) in the columns of *American Machinist*. I have not only seen the wheel center dished on large diameter cast steel centers by tire shrinkage, but have seen cast iron hubs cracked by too much material being left on the pin fit, and the other things Mr. A'Hearn mentions.

In a pair of drivers, 72-in. steel centers, the pin was forced to one side 0.25 in. by a spoke sprung from excess shrinkage of a tire. But with the steel centers generally used on 64- to 68-in. drivers, it is not believed that enough change in the pin will be shown by shrinking on a tire to cause worry. In one test the shrinkage was doubled on one tire with a steel center, and the pin was not changed over 0.003 in. That may have been caused by differences in measuring. The tire parted some time during the night. A second tire was turned up and applied with standard shrinkage, and no change could be found in the pin. Pin accuracy, both as to location, contour and smoothness does, however, influence the wear of brass bushing replacements. One test showed as much as three months longer life on one of a pair of main rod floating bushings that had the pin ground, while its mate was 0.056 in. out of round.

Out-of-Round Pins

Main pins have been known to be ⅛ in. out of round between shoppings, which Mr. A'Hearn admits is excessive But why allow even $\frac{1}{16}$ in. when it can be remedied? It is not an uncommon thing to replace main pin floating bushings in the roundhouse several times between shoppings on our heavy power, and if in such cases the pins are reconditioned, they will give better service.

The old formula for shrinkage allowance on press fits of 0.001 in. per inch of diameter would make the allowance on a modern main pin 0.012 inch. It is believed that the compression of the metal around the hole and of the outer layers of steel in the main pin would take this up. It is usually granted that the steel of which the wheel centers of locomotives are made will flow at 40,000 lb. compression pressure and it is customary to use considerably more than this pressure on main pin fits. The writer has seen as high as 400 tons used on main pins of the new heavy duty locomotives that have been installed since 1920, and this without any deflection of the wheel center that could be noticed.

Ancient Boring Methods

In considering cylinder repairs or reconditioning, Mr. A'Hearn says that fuel savings are remote. It is probably true that saving will never be seen as long as present practices of doing the work are maintained. Most railroads still recondition locomotive cylinders with the portable bar, designed during the Civil War, or before, having three tools and plenty of spring and chatter. The finish feed will generally be ¼ in. and never over ⅜ in. The cylinder is sometimes as much as $\frac{1}{16}$ in. taper in its length and $\frac{3}{32}$ in. taper is a common occurrence. The pressure of the tools causes some spring in the cylinder wall, and it is very probable that the majority of the cylinders will average 0.030 in. out of round, or out of true, when bored with this portable boring bar. The last time I timed such a boring bar, it took 7 hr. to recondition a pair of 26 x 32 in. cylinders, from the time the bar was brought to the pit until ready to be taken away.

A Common Defect in Screw Threads

H. W. BEARCE

Co-Chief, Division of Weights and Measures, National Bureau of Standards, Secretary, National Screw Thread Commission

IN SPITE of the progress that has been made in recent years in the production of accurate and dependable screw threads, there is one defect that still occurs with alarming and seemingly unnecessary frequency. That defect is that the threads on bolts and screws are cut to an excessive depth and sharpness at the minor diameter.

This excessive sharpness at the root of the thread results in a reduction of minor diameter and a corresponding reduction in the load carrying capacity of the threaded member under normal tension, and it also produces a condition that is almost certain to result in ultimate failure if the member is subjected to repeated vibrational stresses.

It is well known that fatigue failure is likely to start at a sharp angle. If no sharp angles are present such failure is much less likely to occur. The avoidance of sharp angles in screw threads subject to vibration is therefore highly important.

Two striking examples of the results of excessive thread depth have recently come to my attention. A large number of threaded test specimens were purchased from a well-known manufacturer of bolts and nuts for use in an important investigation of impact stresses by the Bureau of Standards. These specimens were found to have been cut so deeply at the minor diameter as to interfere seriously with the interpretation of the measurements. In the second case, two men lost their lives as the direct result of failure of a threaded joint in an airplane stay-wire, the failure being a very evident case of fatigue fracture which started at the excessively sharp roots of the thread.

It will be interesting to inquire why this condition of excessively deep and sharp threads occurs, and what, if anything, can be done to remedy the defect. The reason is not difficult to find. The remedy may be quite another matter.

The American national form of thread requires that the minor diameter of bolts and screws shall not be less than that corresponding to a basic flat equal to one-eighth of the pitch. The minor diameter may be above this minimum by an amount depending upon the pitch of the thread and upon the class of fit. (For numerical values of minor diameter see 1928 Report of the National Screw Thread Commission).

In the gaging of screw threads by the methods ordinarily used, it is customary to use a "go" ring gage to insure that the bolt or screw is not too large on the pitch diameter or the minor diameter, and a "not-go" ring or snap gage to insure that it is not too small on the pitch diameter. But ordinarily there is nothing to insure that it is not too small on the minor diameter. The thread might be cut to a sharp V at the root and still pass all gages. With this situation the natural tendency, of course, is for the manufacturer of screws and bolts to see to it that all dies, chasers, single point threading tools are sufficiently sharp so that the product will be sure to pass the "go" gage without danger of interference at the minor diameter. He does not concern himself particularly as to how much sharper it is than the specification permits, since he knows that in all probability this element will never be checked.

A further condition that has tended in the same direction was that until recently some of the best known gage manufacturers made their "go" ring gages with a minor diameter corresponding to the basic ⅛ flat; that is, to the minimum minor diameter permitted. The use of such a gage resulted in the rejection of product because of interference at the minor diameter, not because the product was too large, but because the gage was too small on the minor diameter.

The National Screw Thread Commission recommends that the minor diameter of the "go" ring gage be the same as the minimum minor diameter of the nut; the tolerance on the minor diameter of the gage being minus. This practice insures that any screw or bolt accepted by the "go" ring gage will enter a nut or tapped hole having the minimum minor diameter permitted.

Thanks to the "missionary work" of a few competent gage engineers this difficulty with respect to the "go" gage has now been largely overcome. Die and chaser manufacturers, however, are still making many of their threading tools excessively sharp at the point, with the result that many screws and bolts, if correct on pitch diameter, are too small on minor diameter.

The remedy for this condition would seem to be more careful checking of the threading tools, by optical or other means, and examination or gaging of the product to see that the threads are not sharper at the root than the permissible ⅛ flat. The development of a convenient, rapid and dependable gage for this purpose is highly desirable.

Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

Screw Thread Revisions Proposed—*Discussion*

FRANK C. HUDSON

The difficulties of designating screw thread fits for Class 4 are clearly pointed out by H. W. Bearce (*AM*—Vol. 76, page 933) where he shows how gage tolerance and wear play an important part in securing these close fits. Also, the fact that we must consider not only P.D. but thread angle and lead complicates matters seriously. In most cases, however, lead does not seriously affect fit in thread engagements of ordinary length, even though slight lead errors might easily cause rejection of Class 4 screws. In reality any ordinary lead difference disappears the first time the nut goes on the screw, due to flow of metal in the threads.

There are cases in which cotters were formerly considered necessary to prevent the loosening of nuts due to vibration where the cotters have been abandoned in favor of tight fitting nuts. It has been found much cheaper to select nuts that will be a good wrench fit than to fuss with cottered nuts, drilled bolts and matching the slots to the hole. A good wrench fit overcomes any slight error of angle, P.D. or lead and makes a tight fit that rarely jars loose.

Some engineers of long experience are advocating this as the most practicable way of securing a really good thread fit. They cite the way in which a Whitworth 55-deg. angle bolt fits in a 60-deg. American standard nut and the adoption of a 55-deg. angle for the body fit end of studs by several large users. Isn't it possible that the Class 4 fit might well be abandoned in favor of the wrench fit method for work requiring a really good fit?

EDITORIALS

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EDITORS

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Codes of Ethics

Most of the trade associations in our industry have drawn up codes of ethics that endeavor to state the rules by which the game of business should be played —and is played, in general, when times are good. In these days when the Senate is ruthlessly baring the market operations of New York bankers, and at the same hearing one of its more vocal members score it for cowardice in failing to face facts and reduce swollen budgets; when unscrupulous employers are paying starvation wages and defaulting on payments for machinery; when some former leaders have sought safety abroad, one must have considerable temerity to raise the question of unethical tactics in equipment merchandising. Nevertheless we do suggest that it would be salutary to get out the code of ethics, dust it off and read it over once more.

High Wages Make Machines Profitable

Lowered wages decrease the purchase of consumer goods, of course, but they also result in a far-reaching disadvantage to the makers of machine equipment. During a recent discussion of machine tool costs at the S.A.E. meeting in Detroit it was plainly shown that the lowered wage rates now prevailing in the automobile and other industries are making it difficult for new machine tools to show savings that warrant their purchase. Add to the very low wage rates the present tendency to change models and designs and the accompanying danger of early obsolescence, and it becomes exceedingly difficult to show profit in new machines.

Since so much of the cost of a machine tool is in engineering and development, even the same low wage in machine tool shops would not make it possible for tool builders to reduce prices enough to offset the lowered wage rates on production work.

We have boasted, and rightly, of our American standard of living. It is based on wages that permit the purchase of more than the bare necessities. The marvelous development of our semi-automatic machines has been due to high wages. Wages so low as to make hand work or old machines more profitable than new are a decided step backwards. It is to the advantage of all builders of machine equipment to work for the return of wages that make the use of machines profitable.

Beneficent Banker Control

Banker control of manufacturing plants has been the subject of strong language on the part of the controlled, and also it must be said, on the part of their friends. Much of the condemnation has been justified but there is another side to the picture as of today.

A machinery salesman who has been a frequent victim of ruthless price slashing by a competitor whose financial position is bad is authority for what follows. He has lost order after order to this competitor on small jobs from stock, but much to his surprise the usual competition did not develop on a large machine that had to be built for the customer. Investigation showed that the banker who was in control of the competitor had absolutely refused to permit the sales manager to take new business at a loss. Where the sale would result in the conversion of inventory into cash, even at a loss, the banker was willing to countenance price cuts because he was practical enough to realize that the longer the old stock remained on hand the greater the chance of its value being consumed by obsolescence.

If all of the many bankers who are sitting in on the councils of desperate manufacturers should take a similar stand against the acceptance of new business at a loss, there would undoubtedly be a considerable improvement in the competitive price situation and a general betterment of business and sentiment.

The New Inch-Millimeter Ratio

As was to be expected, the recently adopted conversion ratio of 25.4 millimeters equals one inch has aroused criticism, much of which is directed at the Bureau of Standards. Critics consider the change as a concession to the metric system, an objection which is hardly borne out by the facts, even though the standard inch is changed by two-millionths of its length in the process.

We hold no brief for the Bureau of Standards. In this case we feel that it needs no defense. We have opposed it on some questions and upheld it on others. We have always opposed the compulsory adoption of the metric system, mainly for the simple reason that we do not feel that the enormous cost of making the change would be justified by any benefits that could possibly result from the shift to the metric, or any other system.

It does not seem to us that the metric system has any advantages over the inch, as used in the building of machinery. We are constantly reminded that the

great bulk of the machinery in the world is built to inch measurements. And anyone who wishes to use metric dimensions is at perfect liberty to do so.

In spite of our strong leaning to the inch measurement we believe that the new ratio of 25.4 : 1 is a practical step in the right direction, as a means of lessening errors where measurements must be translated from one system to the other. Even though the inch has been changed by two parts in a million, we feel that any possible loss of prestige is offset by the practical advantages gained.

High Pressure Salesmanship

Thirty-eight plant engineers were asked three questions: Do you receive industrial salesmen? Has a paint salesman called on you recently? Did he give you any good reason why you should repaint your plant at the present time?

Twenty-four answered.

Seventeen said yes to the first question.

Twelve said yes to the second question.

One said yes to the third question, but an interview proved that he didn't really mean it.

If this is typical of "high pressure" salesmanship of industrial products let's try some other kind.

CHIPS

All eyes on Washington as new administration gets ready to take hold . . . Assassin attempts life of Roosevelt in Florida . . . "gets" Mayor Cermak of Chicago and four others in crowd . . . Congress adopts resolution repealing prohibition amendment and states start ratification machinery . . . Roosevelt makes cabinet announcements that draw general approval, even from Republican newspapers . . . Selection of Douglas of Arizona, bonus foe, as director of budget reassures business.

Bank holiday in Michigan following failure of R.F.C. to grant emergency loan alarms financial centers . . . Henry and Edsel Ford offer to take over two leading Detroit banks and supply capital for their reopening . . . Various observers attribute difficulty to Congress action in forcing loan publicity . . . Maryland governor declares short bank holiday in that state . . . Senate's investigation of the National City Bank and its affiliate, the National City Company, while undoubtedly necessary, comes at the worst possible time . . . Charles E. Mitchell resigns all positions with National City group . . . Hoover signs Couzens resolution giving Comptroller of the Currency authority to permit national banks to freeze assets as state banks may do in case of runs . . . Heads of 14 big insurance companies and savings banks in the East sign agreement to "proceed with the utmost forbearance" in every case of a mortgage where any forbearance is at all justified . . . Dayton and Akron banks limit withdrawals . . . Remedial legislation to be rushed in Ohio.

League of Nations votes censure of Japanese action in Manchuria . . . Japanese delegation withdraws and army starts major offensive against Jehol province . . . U. S. note concurs in League policy toward Japan and China . . . Japanese buyers of machine tools and other items hasten to get purchases out of country before any embargo can overtake them . . . British official at Geneva proposes arms embargo . . . Fighting on two fronts continues in South America—Bolivia-Paraguay and Peru-Columbia . . . Nazis move to control German police and seize rule by force if they fail in elections . . . situation grave . . . Hitler overtures to Mussolini portend a new alignment of nations in Europe and worry France . . . French bureaucrats strike to forestall salary cut legislation . . . taxpayers equally hostile to talk of increased taxation . . . Roosevelt's conferences with Claudel and Lindsay arouse hopes of concerted action on debts and economic problems . . . Tension in Balkans grows.

Coal companies that maintain machine shops are planning to make some replacements in 1933 . . . Total may amount to $25,000 or more . . . Kenya Colony gold strike (at Kakamega) may lead to appreciable equipment purchases in this country . . . New gold finds in Ontario also look interesting . . . South Africa's abandonment of the gold standard expected to make the exploitation of lower grade ores profitable . . . New, cheaper variable-pitch propeller arouses interest in airplane circles . . . Service, New York to Los Angeles, from 5 P.M. to 9: 30 A.M. next morning, to start soon . . . Night planes most used today . . . New types of small houses, steel framed and employing new materials, will feature Chicago World's Fair . . . Electric power output off slightly but discrepancy from same week last year less than since beginning of 1932 . . . Penn Water & Power Co. earned more in 1932 than in 1931, $4.93 per share . . . Liquid Carbonic orders seven large gas pumps and one heavy-duty chemical gas pump . . . Locomotive crane manufacturers resolve to refrain from supplying engineering drawings to customers.

Southern Pacific applies for work loan . . . Wrigley raises wages of his employees to hasten recovery . . . Willys-Overland in friendly receivership . . . production stops on passenger cars . . . employees who have had no pay since receivership began talk strike . . . Bradstreet and Dun services merge . . . Steel production recedes, largely because of Michigan troubles . . . prices steady.

Demand for Anti-Trust Law Relief Faces New Administration

A change in administration will not stem efforts to modify anti-trust legislation. Representatives of a number of groups, interested in removing the restrictions which they claim cripple the possibility of constructive industrial planning, recently presented to the House Judiciary Committee a statement stressing the need of emergency action in this direction. Among those supporting this statement were C. E. Bockus, president of the National Coal Association; Wilson Compton, National Lumber Manufacturer's Association; Rush Butler, chairman of the commerce committee, American Bar Association; Walker D. Hines, Walter Gordon Merritt, Howard Coffin, William M. Ritter, William S. Bennet and Matthew Woll, American Federation of Labor.

Placing anti-trust laws among the barriers to economic recovery, through the operation of which manufacturers are helpless to prevent the forcing down of prices and wages, the committee recommended that Congress should:

1. Immediately enact interim emergency legislation to make clear the right of self-regulation of industries by voluntary cooperative action; and,

2. Investigate the operation of the anti-trust laws including that of the proposed interim legislation.

Consideration of the central thought of the Capper-Volstead Act, which would permit cooperative arrangements in production and distribution, was urged. The committee stated that it believed such legislation would hearten the people by correcting unemployment, increasing purchasing power and improving commodity prices. Another bill, introduced in the House on February 22 by Representative J. L. Cable of Ohio, would provide suspension of Federal anti-trust laws by presidential proclamation during periods of depression.

In support of his proposed legislation, Representative Cable states that its essential features have the support of spokesmen representing every phase of our economic life.

The Business Week indicates that President-elect Roosevelt may be favorable to such action if manufacturers in turn will agree to use their sought-for planning privileges to shorten the work day. However, as the same paper points out, anti-trust modification is no panacea in times like these. Independent concerns will continue their price-cutting tactics and be thorns in the sides of advocates of regulation.

A.S.S.T. Selects Meeting Date

October 2-6 has been selected as the week for the 1933 National Metal Congress and Exposition which will be held in Detroit. This is the first time since 1927 that Detroit has been the scene of this annual event. Convention Hall will house the exposition.

Invitations to participate in the congress have already been accepted by the Iron and Steel and Institute of Metals divisions of the American Institute of Mining and Metallurgical Engineers, the American Welding Society and the Wire Association. Undoubtedly other societies regularly meeting with the National Metal Congress will again cooperate this year.

$500,000 Spent for Bus Shop Equipment

According to a survey, recently completed by *Bus Transportation*, about $500,000 was spent last year by bus shops for new equipment. This and other figures concerning the industry are based on reports of 76 companies owning 5,917 buses operating on 37,294 miles of route. Unit figures were obtained and applied to the 42,000 common carrier buses now in service.

Expenditures for materials, supplies, buildings, equipment and buses for 1932 were as follows:

Materials and supplies	$60,462,500
Capital expenditures	
Garages and shops	926,450
Shop equipment	500,000
Terminals	1,688,000
Sub-total, capital expenditures	3,114,450
Sub-total, all expenditures	63,576,950
New buses	12,310,000
Grand total	75,886,950

Fuller Heads Engineering Foundation

GEORGE W. FULLER, member of the firm of Fuller & McClintock, has been elected chairman of the Engineering Foundation, research department of the United Engineering Trustees, Inc. The foundation was founded in 1914 by Ambrose Swasey for the "advancement of research in science and engineering."

INDUSTRIAL REVIEW

Although machinery orders remain as scarce as the proverbial hens' teeth, a sudden and rather impressive increase in inquiries has taken place in most of the important centers. The trade as a whole is praying fervently that these inquiries will be transformed into orders when the new administration takes hold and proves that it is not going to rock the boat.

Boston reports clear evidence of aroused interest through inquiries but remarks that very few have become orders. New York says that activity is practically nonexistent. Philadelphia notes an occasional order but nothing to get excited about.

In Pittsburgh also there has been a considerable improvement in inquiries, accompanied by a distressing tendency to hold them for future decision. A few small orders have been placed. In Cleveland itself business has been receding since the first of the year but manufacturers there have had some encouraging orders from the eastern territory.

Detroit, of course, has suffered severely from the bank holiday. Until that catastrophe things were looking better and some real orders were considered to be more than remote possibilities. Business men have shown a lot of fortitude under this latest blow and there is certainly hope for cooperative action. Indianapolis reports a few orders for new and used machines and is much encouraged by the upturn in volume of inquiries. Reports from Cincinnati differ, some telling of no business or inquiries, others of an increase.

From St. Louis comes word that business is at a standstill. Milwaukee has little machine tool business but reports good orders for gears and printing presses. Chicago has an order or two and is looking for better things after March 4.

Its activities are conducted in cooperation with the four founder societies, the American Society of Civil Engineers, the American Institute of Mining and Metallurical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

Mr. Fuller is known for his experiments in water purification systems which led to the development of methods now used in American cities. He succeeds Hobart Porter, president of the American Water Works and Electric Co.

HARRY P. CHARLESWORTH, vice-president of the Bell Telephone Laboratories, was elected first vice-chairman of the foundation, and H. C. BELLENGER, vice-president of the Chile Exploration Co., second vice-chairman. D. ROBERT YARNALL and JOHN V. N. DORR were named on the executive committee. ALFRED D. FLINN was reelected secretary and treasurer. HAROLD V. COES and ARTHUR S. TUTTLE were made members of the board.

Champlain Becomes Westinghouse General Works Manager

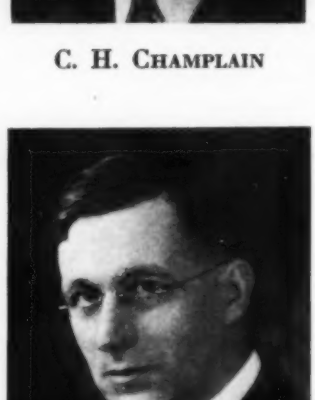
C. H. CHAMPLAIN has been appointed general works manager of the Westinghouse Electric & Mfg. Co. T. I. PHILLIPS, formerly works manager of the Nuttall plant, succeeds Mr. Champlain as works manager of the East Pittsburgh works of the company.

W. OSWALD has been made superintendent of the Nuttall plant, and Mr. Phillips will also remain in charge in a supervising capacity. J. M. HIPPLE, formerly general works manager, has been appointed general manager of merchandising engineering.

Starting with Westinghouse as a machinist in 1898, Mr. Champlain rose to more responsible factory duties and for twelve years had charge of various phases of the manufacture of electrical equipment. In 1915 he was put in charge of munitions manufacture at East Pittsburgh and later sent to East Springfield in charge of rifle manufacture. In 1919 he returned to East Pittsburgh as assistant works manager and four years later went to Sharon, Pa., to build and organize a transformer plant. In 1931 he became works manager at East Pittsburgh.

Mr. Phillips, born in England, was employed as an apprentice at the East Lynn plant of the General Electric Co. from 1904 to 1908. He later served as a toolmaker with the United Shoe Machinery Co., Mergenthaler Linotype Co. and the National Cash Register Co. In 1915 he joined the Westinghouse organization and held various positions.

C. H. CHAMPLAIN



T. I. PHILLIPS

He was made works manager of the Nuttall plant in 1930.

Mr. Hipple has been with Westinghouse ever since his graduation from Ohio State University in 1898. From 1900 to 1911 he worked on d.c. motor design and was then made manager of the motor engineering department, in which capacity he had charge of design for all industrial apparatus. In 1927 he was made East Pittsburgh works manager and in 1931, general works manager.

Ball Bearing Standard Approved

A revision of the American tentative standard for annular ball bearings, single row type (B 3a-1930), was approved by the American Standards Association in January with the designation B3. 1-1933.

This revision consists of a change from 0.4 and 1.0 mm. to 0.6 and 1.5 mm. respectively in the dimensions for the maximum radius r of the fillet of the shaft or housing and the minimum height H of the shoulder on the shaft for the light type bearing No. 39. The revision also includes the addition of the separable (open) type ball bearing and of the annular contact type ball bearing in the light, medium and heavy sizes. The A.S.M.E. and the S.A.E. are sponsors of this project.

Exports of Machinery During January, 1933

	Jan., 1933	Dec., 1932	Jan., 1932
Electrical machinery	$3,085,903	$3,193,175	$3,641,042
Power generating machinery (except electric and automotive)	220,538	300,626	471,011
Construction machinery	203,490	254,463	342,121
Mining, well and pumping equipment	990,571	977,455	860,212
Power driven metal-working machinery	576,134	714,705	835,958
Other metal-working machinery	93,734	123,685	113,968
Textile machinery	332,049	333,932	487,089

Exports of Metal-Working Machinery During January, 1933

	Jan., 1933	Dec., 1932	Jan., 1932
Engine lathes	$17,333	$14,250	$21,018
Turret lathes	12,187	19,710	11,975
Other lathes	13,057	75,837	26,675
Vertical boring mills and chucking machines	7,800	11,286	82,055
Thread cutting and automatic screw machines	1,546	37,146	22,429
Knee and column type milling machines	32,140	20,241	.....
Other milling machines	23,840	34,181	17,066
Gear-cutting machines	44,826	83,361	24,112
Vertical drilling machines	4,199	4,047	10,316
Radial drilling machines	29,035	3,164	4,840
Other drilling machines	27,312	4,143	33,491
Planers and shapers	1,068	4,896	25,407
Surface grinding machines	6,569	4,705	15,330
External cylindrical grinding machines	18,394	9,154	19,127
Internal grinding machines	2,515	21,199	36,704
Tool grinding, cutter grinding and universal grinding machines	29,814	20,227	17,247
Other metal grinding machines	20,710	9,884	13,643
Sheet and plate metal working machines	48,424	135,556	40,302
Forging machinery	9,277	15,662	100,131
Rolling mill machinery	9,734	34,509	18,776
Foundry and molding equipment	52,044	17,402	18,775
Other power driven metal-working machinery and parts	64,310	134,137	276,539

Other Metal-Working Machinery

Pneumatic portable tools	$10,953	$26,655	$32,477
Other portable hand operated machines and parts	19,299	19,545	24,466
Chucks for machine tools	2,892	3,358	2,801
Machine operated pipe and thread cutters, socks, dies, taps and other machinery operated cutting tools	41,670	41,553	30,477
Other metal-working machine tools	18,920	32,574	23,747

Machine Tool Orders Drop in January

Although the three-months' index of gross orders, as reported by the National Machine Tool Builders' Association, was higher in January than for any month since July, 1932, the January orders did not maintain the levels reached in the preceding two months. The drop from 35.8 in December to 31.6 in January was somewhat of a disapointment because of the favorable reports of orders received during the month. The figures show that business was spotty even in the A group which made the best showing. Only 7 of 25 companies reporting in this group received a volume of orders better than 40 per cent of their respective losses.

The B and C groups showed up rather poorly, receiving little of the foreign business reported. Unfilled orders rose for the fourth successive month, but this was chiefly caused by the low volume of shipments with an index of only 26.0.

January Orders for Machine Tools

	Index A	Index B	Index C	Total
Number of reports	25	28	23	77
Class bases	$2,594,127	$673,342	$141,228	$3,408,697
Gross orders for month	34.9	19.5	29.1	31.6
Cancellations	0.1	2.5	0.0	0.5
Net orders	34.8	17.0	29.1	31.1
Shipments	27.4	19.6	32.2	26.0
Unfilled orders	45.7	55.9	64.8	48.6
Three-months' average of gross orders	33.9	27.7	45.1	33.1

Base — Average shipments for years 1922-24.
Index A — Base more than $50,000.
Index B — Base $10,000 to $50,000.
Index C — Base less than $10,000.
Total — The "total" indexes are not averages of A, B, and C indexes but are percentages of the totals of the respective items to the total bases of all reports filed each month.

Chicago Meeting to Stress Shop Practice Trends

The Chicago section of the American Society of Mechanical Engineers will hold its annual Machine Shop Practice meeting on Thursday, March 30, at the Auditorium of the Engineering Bldg., Chicago. C. B. Cole, president of the Tool Equipment Sales Co., will be chairman. Papers to be presented will show the trend and interesting developments in machine tools, new cutting metals, and the latest design in boring bars and multiple cutting tools. Members of the following societies have been invited to cooperate: Western Society of Engineers, Chicago Engineers Club, Superintendent's and Foreman's Association, American Machinery & Tools Institute, Purchasing Agent's Association and the Illinois Manufacturers Association.

Re-Engineering Subject of Case Conference

For the third year, the Case School of Applied Science is presenting a series of conferences to review progress in a particular phase of technical industry. On March 22, 23 and 24 a conference will be held on the subject "Re-Engineering for Economical Manufacture," with the aim of indicating ways of modifying present methods to obtain decreased costs. The first meeting on the evening of March 22 will be a joint session with the Cleveland Engineering Society and the American Society of Mechanical Engineers. The program is as follows:

March 22, evening.

Planning for Profits Discussion.

March 23, morning.

Introduction—Dr. W. E. Wickenden, president, Case School of Applied Science.

Production—Wither Bound?—E. L. Shaner, Editor of *Steel*.

Redesign of Product to Increase Appeal to the Purchaser— R. E. Hellmund, chief electrical engineer, Westinghouse Electric & Mfg. Co.

Developments in Manufacturing Processes—D. Levinger, Engineer of Manufacture, Western Electric Co.

March 23, afternoon.

Selection of Equipment—H. P. Bailey, president, Rotor Air Tool Co.

Changes in Plant Layout to Accomodate Varying Production.

March 24, morning.

Metal Forming to Eliminate Machinery—Charles D. Harmon, The National Machinery Co.

The Place for Stampings in the Product—J. K. Olsen, chief draftsman, Stewart-Warner Corporation.

Influence of Welding Design and Production—R. E. Kinkead, consulting engineer.

March 24, afternoon.

Manufacturing Quantities for the Small Industry—J. C. Wattleworth, factory manager, Vichek Tool Co.

Operation Study—R. M. Blakelock, General Electric Co.

Oster Has 40th Birthday

An informal gathering of officers and employers of the Oster Manufacturing Co. met at the home of Arthur S. Gould, secretary, to celebrate the 40th anniversary of the company's founding and the third of its merger with the Williams Tool Co. Henceforth the combination will be known as Oster-Williams although the individual corporate names will not lose their identity.

Improvements Made in French Machinery

New methods and improvements in old techinques have been steadily adopted for French industrial machinery, according to a trade report from the Department of Commerce. Despite the economic depression, manufacturers have taken the opportunity to study technical improvements in many lines.

Among the more outstanding developments reported:

Electric arc welding is now widely used. The use of die-casting is spreading. More die-casting machines were sold during the past year than during the preceding five years.

Book-binding machinery is used more extensively. Centerless grinding machines are now widely used for the manufacturer of small pieces as well as for calibrating bars. Paint is no longer considered of secondary importance by French machinery manufacturers.

•BUSINESS ITEMS•

At the annual meeting of the Cadillac Machinery Co., Detroit, the following directors were elected: Colin L. Campbell, chairman of the board, Thomas Redmond, Kennedy H. Crumrine, Charles Robertson and Edward Busch. Officers for the ensuing year are: Thomas Redmond, president; Kennedy H. Crumrine, vice-president; Edward Busch, treasurer, and Frank Donavan, secretary.

Otto Lundel, president of the Michigan Tool Co., Detroit, has announced that distribution of his company's products will be handled by Colin L. Campbell, Inc., and Cadillac Machinery Co., Detroit. These products include a gear-finishing machine, a new gear-lapping machine, a hob-testing machine and the two broach sharpening machines built by the Colonial Broach Co., of which Mr. Lundel is also president.

Cadillac Machinery Co., 623 Fisher Bldg., Detroit, Mich., has been appointed exclusive dealer in the Detroit territory by the Bryant Machinery & Engineering Co., Chicago, for the following lines of machinery: Ohio horizontal boring, drilling and milling machines, Cleereman drilling machines and Imperial arc welders. The Detroit company also represents Boye & Emmes engine lathes. Bryant Machinery & Engineering Co. is general distributor for the manufacturers of these lines of machine tools.

The Apex Electrical Mfg. Co., 1067 E. 152nd St., Cleveland, Ohio, is developing a sales organization for its fractional-hp. motor division and has provided additional engineering and production facilities at its new plant. J. E. GREGORY has been appointed sales engineer.

Foote Bros. Gear & Machine Co., Chicago, has appointed WILLIAM E. PECK to succeed RALPH WIRTH in the Indiana territory, except for certain counties.

The Davis & Thompson Co., Milwaukee, Wis., according to F. M. DAVIS, president, will hereafter be represented by The Riordan Machinery Co., in the Detroit district.

The Swanson Mfg. Co., Ottumwa, Ia., has moved into larger quarters at West Samantha St., and has started production on washing machines and later will manufacture electric ironing machines.

The Austin Co., 16112 Euclid Ave., Cleveland, Ohio, has developed a welding division for the fabrication of steel machinery parts by gas cutting, forming, and arc-welding. Technical aid is available for the development of designs in welded steel or for redesign of castings.

At the annual meeting of the Farrel-Birmingham Co., Inc., Feb. 16, the board of directors elected FRANKLIN FARREL, JR., as chairman of the board, and NELSON W. PICKERING as president.

• PERSONALS •

CHARLES H. CHAMPLAIN, formerly works manager of the East Pittsburgh Works, Westinghouse Electric & Mfg. Co., has been made works manager of all of the company's plants. Before going to Pittsburgh in 1931, Mr. Champlain was head of the Sharon, Pa., works. T. I. PHILLIPS succeeds Mr. Champlain as works manager at East Pittsburgh, and will also be in charge of the Nuttall works.

FLOYD O. TANNER, vice-president and general plant manager of Pontiac Motor Co., has been named director of manufacturing of both Chevrolet and Pontiac with offices in Detroit. The announcement was made by C. E. WETHERALD, vice-president and general manufacturing manager, Chevrolet Motor Co. P. H. MACGREGOR, formerly general superintendent of the Chevrolet plant at Flint, Mich., succeeds Mr. Tanner at Pontiac.

LAIRD BELL has succeeded DONALD M. RYERSON, deceased, as a director of Joseph T. Ryerson & Sons, Chicago. The office of chairman of the board, held by the late Mr. Ryerson, has been abolished.

HAROLD D. CHURCH, vice-president of the White Motor Co., Cleveland, has been made vice-president in charge of engineering and manufacturing at the Winton Engine Corp., Cleveland, a subsidiary of General Motors Corp.

RAYMOND L. COLLIER, assistant managing director for many years of the Steel Founders' Society of America, has been appointed managing director to succeed GRANVILLE P. ROGERS, resigned.

JOHN C. REESE has been made purchasing agent of Continental Motors Corp., Detroit, and the subsidiary companies. He recently acted in the same capacity for the automobile division of the corporation.

H. W. STRONG has been elected president of the Strong, Carlisle & Hammond Co., Cleveland machinery dealer, succeeding L. J. HAMMOND. Mr. Strong continues to be general manager as well.

• OBITUARIES •

JAMES H. JOWETT, executive vice-president of Ingersoll-Rand Co., and a member of the board of that concern and of its affiliate company, the A. S. Cameron Steam Pump Works, died Feb. 16 at the age of 58. For a number of years he had been intimately in touch with all phases of the company's activities. He was a member of the American Society of Mechanical Engineers.

WILLIAM T. BEATTY, 69, president of the Austin Mfg. Co., Harvey, Ill., manufacturer of road machinery, died recently. He was president of the company since 1911.

ARTHUR M. COTTRELL, 62, president of C. B. Cottrell & Sons Co., manufacturers of printing presses, died Feb. 23.

OTTO A. EHBE, 72, general superintendent and secretary-treasurer of the Milwaukee Boiler Mfg. Co., Milwaukee, Wis., died recently. He had been superintendent since 1903.

WILLIAM R. HILL, president since 1923 of Sargent & Greenleaf Co., lock manufacturer, died recently at Rochester. He was 65.

HARRY G. NYE, president since 1904 of the Nye Tool & Machine Works, Chicago, Ill., died recently. He was 59.

CHARLES C. RANSDELL, former president of Gilbert & Parker Mfg. Co., Springfield, Mass., died recently. He had been connected with the company for 40 years and resigned last Nov. 1 to become western Massachusetts regional manager of the state campaign in the share-the-work movement.

J. C. STINE, a founder of the J. C. Stine Co., manufacturer of mining machinery, Tyrone, Pa., died recently. He was 65.

CHARLES A. YOUNG, 74, president of the Young Brothers Co., manufacturer of industrial ovens, Detroit, died Feb. 17. Mr. Young organized the company in 1896.

• MEETINGS •

AMERICAN SOCIETY FOR TESTING MATERIALS. Annual Spring group committee meetings. March 6-10. Fourth New York regional meeting. March 8. Both meetings at Hotel New Yorker, New York, N. Y. Thirty-sixth annual meeting, June 26-30. Chicago. C. L. WARWICK, secretary, 1315 Spruce St., Philadelphia, Pa.

AMERICAN WELDING SOCIETY. Annual meeting. April 27-28. New York, N. Y. Miss M. M. KELLY, secretary, 29 West 39th St., New York, N. Y.

CASE SCHOOL OF APPLIED SCIENCE AND THE CLEVELAND ENGINEERING SOCIETY. Joint conference on "Re-Engineering for Economical Manufacture." March 22-24. Case School of Applied Science, Cleveland, Ohio. PROF. E. S. AULT, chairman.

GRAY IRON INSTITUTE. Annual meeting. March 22. Hotel Cleveland, Cleveland, Ohio. ARTHUR J. TUSCANY, manager, 4300 Euclid Ave., Cleveland, Ohio.

NATIONAL FOREIGN TRADE COUNCIL. Twentieth national foreign trade convention. April 26-28. Hotel William Penn, Pittsburgh, Pa. GARDNER L. HARDING, secretary, India House, Hanover Square, New York, N. Y.

Larger Quarters

"Say, Ed, you know the Morgan property, don't you?"

"Sure, what about it?"

"Mason and I are thinking of renting it. You remember I told you I was house hunting."

"I know you did, but I didn't take you seriously. I didn't think anyone would be foolish enough to move into expensive quarters and buy new machinery at a time like this. What's the matter with you and Mason that you can't leave well enough alone?"

"Nothing is the matter with us. We need more manufacturing space, and the Morgan property can be leased dirt cheap. I don't see anything foolish in that."

"You wouldn't, but it looks to me like a little success has kind of warped your judgment. I thought, the way you started out, that you were going to prove an exception to the rule, but now you are running true to form."

"What do you mean by true to form, Ed?"

"I mean that, almost without exception, when men have a little money, and quit working for others and start in business for themselves, they seem to think that success depends upon the appearance they make. They rent an imposing office and fill it with expensive furniture. If they happen to be mechanics like you and Mason, they buy a lot of machinery they could do just as well without. The result is usually that the bank eventually carries them, or they bust. Don't forget, when the bank carries anyone, it owns him."

"We didn't start that way, Ed. We started in a garage and paid no rent, we owned an old lathe, a shaper and a drill press, and bought a second-hand grinder. You wouldn't call that splurging, would you? Our rent will be high by comparison, because we haven't been paying any. True, we'll have more room than we need right now, but you can't pick up a factory like the Morgan property more than once in a lifetime. We'd be foolish not to snap it up when we have the chance."

"Under some circumstances, yes; but this is no time to take a chance."

"Don't croak, Ed. Remember that poem of Poe's that we used to recite at school—about the raven that perched above the door and croaked 'nevermore'? Well, you're just about as encouraging as that bird was. Mason and I have been lucky. We have made some money and have a product that will sell about as readily in hard times as in good, because the savings are so obvious. We've had mechanical and refrigerating engineers test our new model and feel sure that we can sell all the compressors we can produce with the machinery we can afford to buy. We are going to run in debt for only ten per cent of our new equipment, and any business justifies that."

"Maybe it does, but you admit that you're running into debt and that your prospects are based on guesswork. It's funny a man can never be satisfied to be making money in a small way. He'd much rather be losing money on a large scale. Why don't you be satisfied to go on as you are for awhile, until things look brighter?"

"Because we can't make decent deliveries on those we sell, and unless we expand we'll have to turn away buyers. Doing that is not good policy regardless of conditions."

Is Al justified in increasing his manufacturing facilities on the basis of probable future business? Should he run in debt for machinery or wait until he can pay for it out of earnings?

Discussion

Another New Model

From the standpoint of the maker there is, of course, a limit to the frequency at which changes and improvements are practical; but from the standpoint of the user, the more often improvements can be made the better. Ordinarily, a machine is not purchased because it is "the latest thing in its line," but rather because it will do the job for which it is intended in the most efficient and economical manner at the time of purchase.

I would much rather buy the last of a model, which had superseded an older and less efficient one two or three years ago (to be in its turn superseded), than to buy one which had not been changed for ten years, and might not be for another ten.

The exact time at which improvements should be made generally available is a question to be decided by the best judgement of the maker and will vary with each individual case. No one wants to buy an experiment unless the possible gain is large enough to justify the risk. On the other hand, where a real gain in efficiency is possible, it would be too bad to delay its realization merely to avoid a waste of materials which the maker might have on hand. Possibly, in such cases, some price adjustment might be

made to take care of the situation. In case the probable gain was not great enough to absorb the extra cost, it would be better to continue the older model. —N. G. MORGAN.

In most cases, there is no need for worrying about disposing of the old model when a new model is introduced. For there are plenty of people who want to continue using what they have been using, no matter how much better the new model is. That was very noticeable when the Model T Ford was discontinued. There was a considerable demand for good used cars of the old model from people who could well afford the new.

We have found the same thing with tool grinders. A man has three in his shop and wants another like it. He is told of the new improvements, but he wants it like the old ones just the same. In some cases, we have built grinders for these customers of models that had been discontinued five years before.

—A. W. FORBES,
Forbes & Myers.

What's in a Name?

Particularly apt is Al's argument with reference to the costly effect of diverting potential customer interest through the erroneous implication of some firm title, which may perhaps have been entirely descriptive at one time, but which gradual changes in product may make altogether too limiting under present-day conditions.

One of the largest and best-equipped manufacturers of wood products in the country has unquestionably lost considerable potential business because of his early ventures in box making, which saddled his concern with the one-product title of Blank Box Company. A large fabricator of steel plate construction, capable of handling almost unlimited jobs in steel plate and structural work, has had a hard and expensive task convincing an order-giving public that his firm name of The Dash Tank Company is historical and not limiting as regards capability.

A firm name should lend itself to easy impression on the minds of those who read its advertising matter, and this objective implies that it should be short and pointed. For this reason, the single name of owner or founder, or in the case of a partnership, the name of the members of the partnership with no further descriptive matter is ideal. Such a name carries the personal touch of human contact, personal integrity and stability, that no impersonal name, no matter how grandiliquent, can hope to have. —D. C. WRIGHT.

Ed is not overestimating the value of a firm's name. Nation-wide concerns learned long ago the advertising value of a name which is concise, easily remembered, and yet tells all.

In a small town, where everyone knows everyone else, the greatest asset to a business is the name of the proprietor. Where one is so well acquainted, the nature of the business is known to all. It is the proprietor of the shop which is the chief item of interest.

On the other hand, in a larger city and one with growing ambitions, the name of the city and product being sold is the greatest advertising medium—for example, The Akron Rubber Co. Here the proper patriotic spirit is achieved, and the product being sold is made known.

Too many firms make the mistake of trying to secure an imposing name. This usually infers that they can cover a larger territory than they are really capable of covering. A beginning company should tell in its name only the truth, and not, by subtle suggestion, infer something that isn't so.

Another thing that should be taken into consideration is the future of the firm. Is it always going to carry this one line, or is it going to add accessories? Is the proprietor to remain one person, or are others to be taken into the ownership? —WILL HERMAN.

Corporation or Partnership?

There are so many points that make a corporation more advantageous, that the disadvantages are overshadowed. In partnership, the partners put a certain amount of money into the business.

That may be all that they can afford to risk in the venture, but in reality, they are risking everything that they own. Perhaps they realize this fact, and then again they may not realize that if all does not go well they are liable for each and every debt of the partnership, individually and collectively.

A corporation is different; one is only risking the amount of money he puts in. A corporation with a good credit rating has the advantage when it comes to borrowing money from a bank, even though the individuals in the corporation are not personally responsible for the loan.

A good way to do, is to ask yourself this question: Is the extra cost of a corporation excessive, when one considers, this extra cost as an insurance premium, on a policy which protects one's home and family and insures their happiness?

Is it fair for the head of a family to risk the happiness, and the support of his family in a partnership?

—MAURICE H. BAITLER,
Perkins Machine & Gear Company.

No Mistakes

I would like to comment on the interesting article by A. W. Forbes (*AM*—Vol. 77, page 169), particularly that portion wherein Mr. Forbes mentions the reluctance of the average boy to serve an apprenticeship. Let me quote from this article: "Today it is easier to get 100 ordinary machinists at $15 per week than one who can earn $50."

Assuming that the "ordinary" machinist he refers to is one can read a blueprint correctly, set up and run any tool in the shop and turn out work of a reasonable degree of accuracy—in short the "run-of-mine" individual who forms ninety per cent of any shop force—then Mr. Forbes' price quotation is short five or six dollars. I would put the weekly average around $21. If he refers to the machine operator type, then $15 is probably correct. Now let us turn to the highly skilled man who undoubtedly, as Mr. Forbes suggests, "is cheapest for the small shop." I personally am acquainted with several high grade men who are worth more than $50 weekly to their employers. But their envelopes contain at a liberal estimate perhaps $35 on payday.

These men consider themselves fortunate, at least in comparison to their brothers of ordinary or average type. The point I wish to make however is that the financial reward at the end of a period of three or four years of apprenticeship at low wages is not sufficiently attractive to merit the consideration of the average boy of moderate intelligence. Some of us—by way of inducement—may talk inspiringly yet vaguely of Chrysler, Ford and others who "rose from the ranks"; modern youth refuses to be convinced of the ultimate rewards.

If the machinist trade is to attract the right type of boy then the financial reward must be commensurate, otherwise there will continue to be, to again quote Mr. Forbes: " . . . no demand for this kind of training from the boys."

—ROBERT S. ALEXANDER.

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Basic Rack of the 20 Deg Full Depth Involute System for Spur Gearing

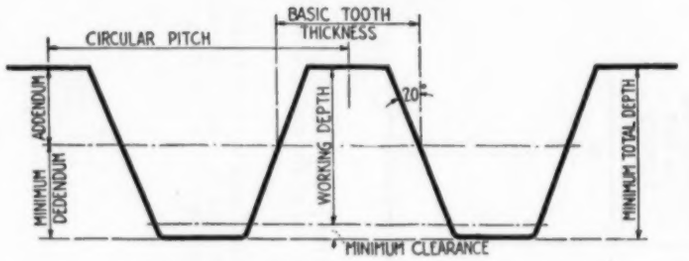

Table 3 Full Depth Tooth Proportions for Spur Gears

		In Terms of Diametral Pitch[1] (Inches)	In Terms of Circular Pitch[1] (Inches)
1.	Addendum	$= \frac{1}{DP}$	$0.3183 \times CP$
2.	Minimum Dedendum[2]	$= \frac{1.157}{DP}$	$0.3683 \times CP$
3.	Working Depth	$= \frac{2}{DP}$	$0.6366 \times CP$
4.	Minimum Total Depth[2]	$= \frac{2.157}{DP}$	$0.6866 \times CP$
5.	Pitch Diameter	$= \frac{N}{DP}$	$0.3183 \times N \times CP$
6.	Outside Diameter	$= \frac{N + 2}{DP}$	$0.3183 \times (N + 2) \times CP$
7.	Basic Tooth Thickness on Pitch Line	$= \frac{1.5708}{DP}$	$0.5 \times CP$
8.	Minimum Clearance[2,3]	$= \frac{0.157}{DP}$	$0.05 \times CP$
9.	Radius of Fillet	$= 1\frac{1}{2} \times$ Clearance	

N = Number of Teeth. DP = Diametral Pitch: CP = Circular Pitch.

[1] NOTE: The term Diametral Pitch is used up to 1 DP inclusive and the term Circular Pitch is used for 3 inches CP and over.
[2] NOTE: A suitable working tolerance should be considered in connection with all minimum recommendations.
[3] NOTE: Minimum clearance refers to the clearance between the top of the gear tooth, and the bottom of the mating gear space, and is specified as "minimum" so as to allow for necessary cutter clearance for all methods of producing gears. At the present time this value cannot be standardized.

Basic Rack of the 20 Deg Stub Involute System for Spur Gearing

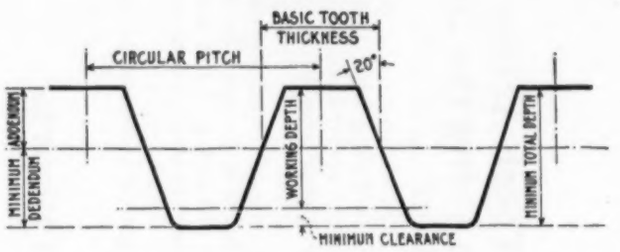

Table 4 Stub Tooth Proportions for Spur Gears[4]

		In Terms of Diametral Pitch[1] (Inches)	In Terms of Circular Pitch[1] (Inches)
1.	Addendum	$= \frac{0.8}{DP}$	$0.2546 \times CP$
2.	Minimum Dedendum[2]	$= \frac{1}{DP}$	$0.3183 \times CP$
3.	Working Depth	$= \frac{1.6}{DP}$	$0.5092 \times CP$
4.	Minimum Total Depth[2]	$= \frac{1.8}{DP}$	$0.5729 \times CP$
5.	Pitch Diameter	$= \frac{N}{DP}$	$0.3183 \times N \times CP$
6.	Outside Diameter	$= \frac{N + 1.6}{DP}$	PD + (2 Addendums)
7.	Basic Tooth Thickness on Pitch Line	$= \frac{1.5708}{DP}$	$0.5 \times CP$
8.	Minimum Clearance[2,3]	$= \frac{0.2}{DP}$	$0.0637 \times CP$

N = Number of Teeth. DP = Diametral Pitch. PD = Pitch Diameter.
CP = Circular Pitch.

[1] NOTE: The term Diametral Pitch is used up to 1 DP inclusive and the term Circular Pitch is used for 3 inches CP and over.
[2] NOTE: A suitable working tolerance should be considered in connection with all minimum recommendations.
[3] NOTE: A minimum root clearance of 0.2 inch/Diametral Pitch is recommended for new cutters and gears. There is correct tooth action, however, between gears cut to this standard system and those cut to the Nuttall system, the only dimension affected being the clearance. Where the proposed gear tooth meshes with a Nuttall gear space there is a clearance of 0.1425 inch/Diametral Pitch, and where the Nuttall tooth runs with the proposed gear space there is a clearance of 0.2146 inch/Diametral Pitch.
[4] NOTE: These proportions are identical with those of the A.G.M.A. recommended practice for Herringbone Gears.

Courtesy of American Standards Association

Standard sponsored by American Gear Manufacturers Association and The American Society of Mechanical Engineers. Approved November, 1932. Concluded from previous number.

Spur Gear Tooth Form—American Standard

(Continued)

Data for Use in Obtaining Full Involute Tooth Action on Pinions of 17 Teeth and Smaller When Using the 20 Deg Full Depth Involute System

To obtain full involute action when the pinion is in contact with a 20 deg basic rack, the outside diameter of the pinion must be increased. To maintain standard center distance where a gear is substituted for the rack, the outside diameter of the mating gear must be decreased the same amount.

Tabulations of the amounts of increase and decrease in diameter and the corresponding circular tooth thicknesses on the pitch line of both gear and pinion are included in the table below.

Long addendum pinions in mesh with standard addendum gears will run with full involute action, but it is self evident that in such cases, the center distance must be increased to suit the standard size gear.

If the sum of the number of teeth in the pinion and the mating gear is less than 34, undercutting will occur in the teeth of the mating gear.

Table 5 Diameter Increments,[1] Plus and Minus for 1 Diametral Pitch[2]

Number of Teeth in Pinion	Diameter[1] Increment	Pinion Circular Tooth Thickness	Mating Gear Circular Tooth Thickness	Min Number of Teeth in Mating Gear Avoiding Undercut	Min Number[3] of Teeth in Mating Gear for Full Involute Action
8	1.0642	1.9581	1.1835	26	16
9	0.9472	1.9156	1.2260	25	16
10	0.8302	1.8730	1.2686	24	16
11	0.7132	1.8304	1.3112	23	16
12	0.5963	1.7878	1.3538	22	15
13	0.4793	1.7453	1.3963	21	14
14	0.3623	1.7027	1.4389	20	14
15	0.2453	1.6601	1.4815	19	14
16	0.1284	1.6175	1 5241	18	13
17	0.0114	1.5749	1.5667	17	13

All dimensions in inches.

[1] NOTE: Diameter increment is the amount by which the outside diameter of the pinion must be increased over the standard outside diameter and also the amount by which the outside diameter of the mating gear must be decreased below standard to maintain standard center distances.

[2] NOTE: For other pitches divide values given by desired diametral pitch.

[3] NOTE: The number of gear teeth, in each case, shown in this column or any larger number of teeth, up to that specified in the preceding column, will produce undercutting of the gear teeth in varying amounts with consequent reduction in strength; the maximum undercutting in each case, occurring with the minimum number of gear teeth.

Courtesy American Standards Association

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• IDEAS FROM PRACTICAL MEN

Press Tools for a Sheet-Steel Casing

HARRY S. TAYLOR

In the unusual conditions and keen competition of these times, production of articles is changing continually, particularly stampings for use in the automotive field. For a concern to get its share of business, great responsibility has been put up to the die department to secure the best possible results at the minimum of cost. Very often the getting of an order hinges upon the cost of the tools and the delivery of the work. Yet the rigid inspection of the work for interchangeability demands close limits.

I believe that one of the greatest savings can be made by designing the tools so as to save stock, avoid costly tryouts and, most important of all, by using materials of standard size and thickness that need the minimum of machining in making tools for short runs when the duplication of orders is uncertain.

For the particular job under consideration, strip stock of the correct width was used. For the first operation, the tools could have been made so that all the piercing could have been done at one time. However, the tools would have been quite large and would have required a large press for their operation. Since the production was uncertain, it was decided to make the tools as shown in Fig. 1 and use them for two operations by providing the extra gage pin *A* and by removing the cut off and forming punches *B* and *C* for the second operation.

To facilitate matters, the stripper *D* was mounted on the punch-holder by four Danly stripper bolts, the stripper being actuated by rubber. The die was made in two sections to make the machining easier. Parts that were left rough are indicated by *R*. The length of the blank, or strip, was predetermined by the designer, as was also the distance between the two bends in the first forming operation, so that no time was lost by the diemaker in determining these dimensions. The first and second operations are indicated in Fig. 2. The third and fourth operations (Fig. 3) are performed in the tools shown in Figs. 4 and 5. As indicated by the heavy, dotted lines, for the third operation the work is placed on the forming die, Fig. 4, over the pins *A* in the pressure pad *B*, locating it from one of the drift holes. The parts *C* of the die and *D* of the punch are the only parts made of tool steel. Both the die-shoe and the die-holder are of cast iron and the pressure pad is cold-rolled steel. These tools are operated in a press equipped with an air cushion.

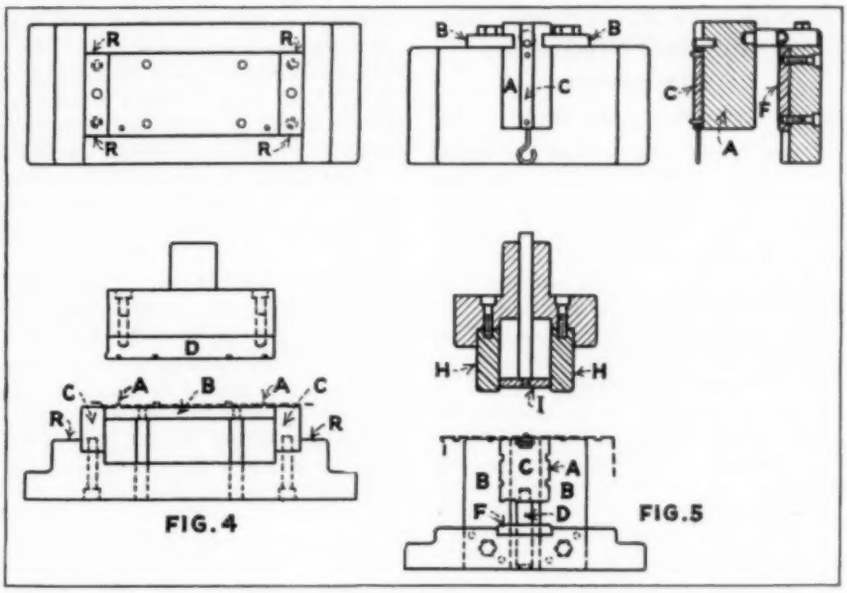


FIG. 4 FIG. 5

Figs. 4 and 5 — Details of pressure pad and horning tools

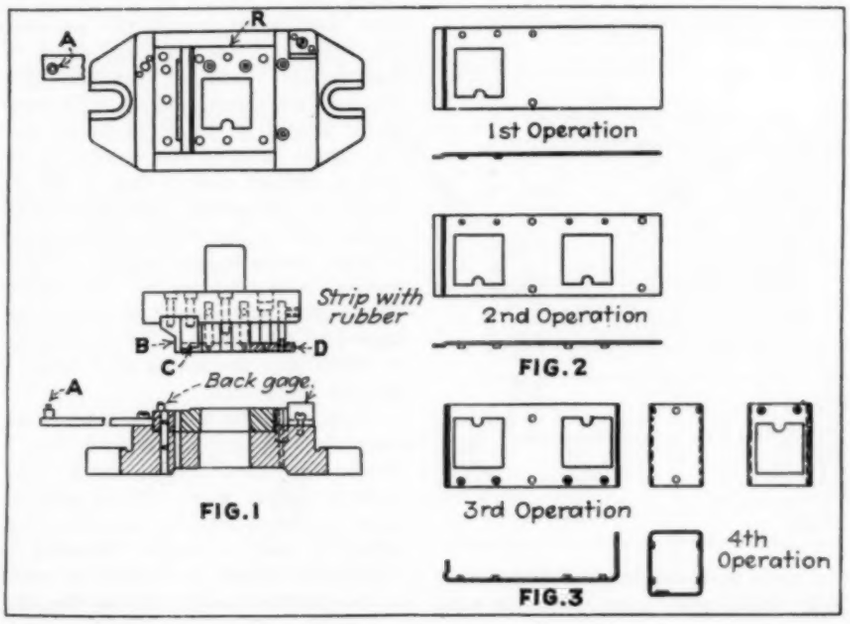


FIG. 1 FIG. 2 FIG. 3

Figs. 1, 2 and 3 — The dies, operation layout and sequence of the four operations. The gages and rubber stripping pad are shown in position

The horning tools for the fourth, and last, operation are shown in Fig. 5. The die is operated by an air cushion and has a core *A* that slides up and down the two gibs *B*, which are attached to the die-shoe at the rear.

Slide *C* in the core carries two pins for

locating the work. Pressure is applied to the core through the shouldered pin *D* between the gibs. The hardened steel plate *F* at the bottom, helps to iron out the fold on the down stroke of the ram. The punch consists of two hardened steel blocks *H* and the positive knockout *I*. These tools work exceptionally well. However, enough air pressure must be applied to the core so that the punch will bend the work down before the core starts to move downward:

The work is placed over locating pins in the slide *C* with the bent sides down, as indicated by the heavy, dotted lines. After the operation has been completed, the finished piece is pushed off of the core by the slide *C*. The core *A* and the punch parts *H* are of tool steel, hardened. The shoe and the holder are cast iron and the stripper is cold-rolled steel.

Inexpensive Press Tools for Economical Production
Discussion

CHARLES F. KRAUT

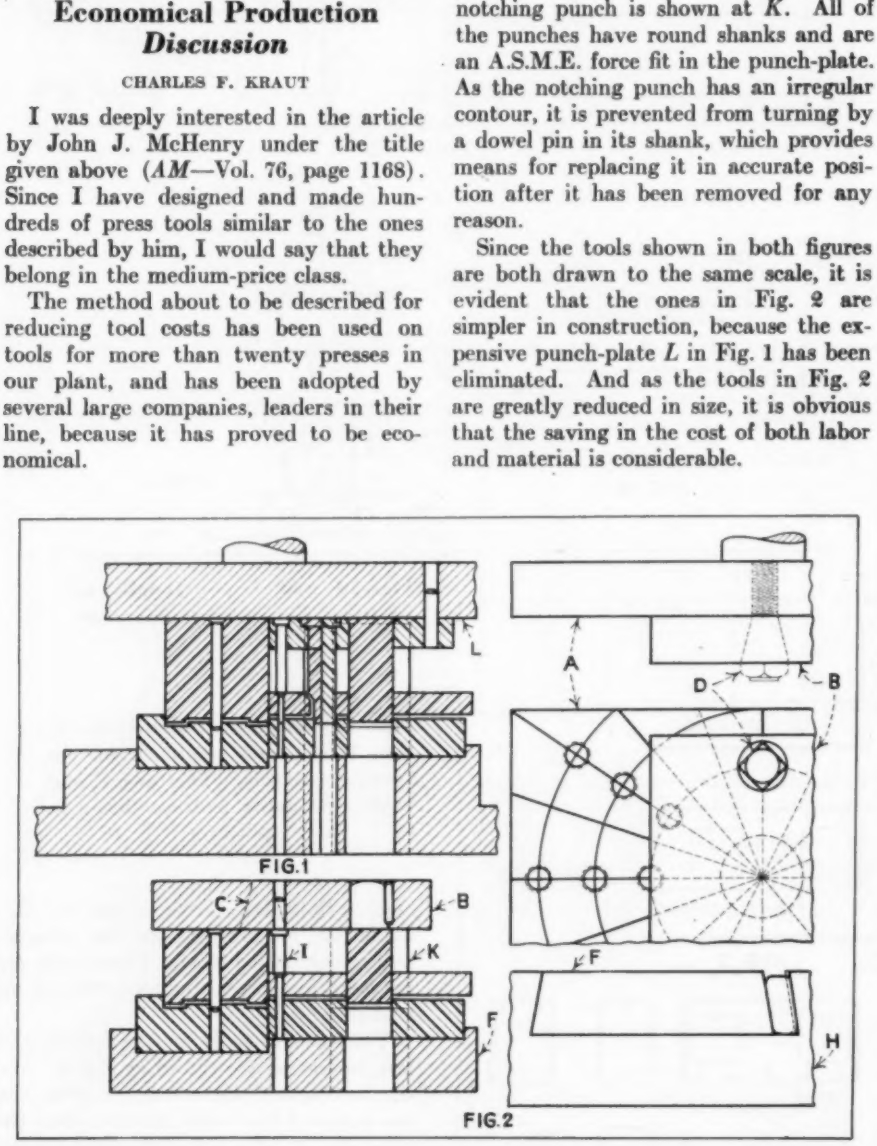
I was deeply interested in the article by John J. McHenry under the title given above (*AM*—Vol. 76, page 1168). Since I have designed and made hundreds of press tools similar to the ones described by him, I would say that they belong in the medium-price class.

The method about to be described for reducing tool costs has been used on tools for more than twenty presses in our plant, and has been adopted by several large companies, leaders in their line, because it has proved to be economical.

The tools described by Mr. McHenry are illustrated in Fig. 1. Had they been designed like the tools shown in Fig. 2, it would have been possible to have cut their cost from 35 to 40 per cent. Referring to Fig. 2, the adapting punch-holder *A* has holes drilled and tapped to provide means for clamping punch-plates, varying in size to suit conditions, to its surface. *B* is the punch-plate; *C* the taper hole for the clamping bolt *D*; *F* the die-shoe; and *H* the bolster, in which the die-shoe is held by a taper key. The adapting punch-holder can be attached to or removed from the press ram as conveniently as can any other holder. Since this holder and the bolster can be used for many jobs over a period of time, the cost of making them should be charged against the press department.

Several of the piercing punches shown in Fig. 1 have been omitted from Fig. 2 for the sake of clearness. One of the piercing punches is shown at *I*, while the notching punch is shown at *K*. All of the punches have round shanks and are an A.S.M.E. force fit in the punch-plate. As the notching punch has an irregular contour, it is prevented from turning by a dowel pin in its shank, which provides means for replacing it in accurate position after it has been removed for any reason.

Since the tools shown in both figures are both drawn to the same scale, it is evident that the ones in Fig. 2 are simpler in construction, because the expensive punch-plate *L* in Fig. 1 has been eliminated. And as the tools in Fig. 2 are greatly reduced in size, it is obvious that the saving in the cost of both labor and material is considerable.

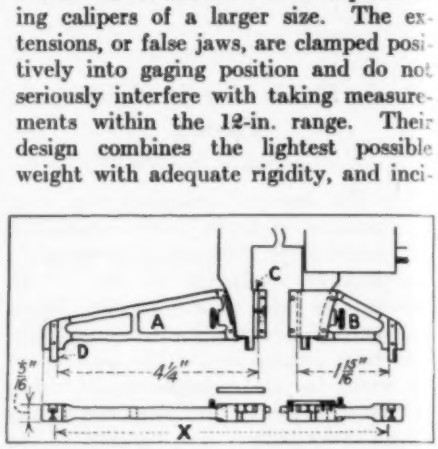


Figs. 1 and 2—Showing construction of press tools designed for low first cost as well as efficient production. The second design eliminates expensive punch plate

Extensions for Vernier Calipers

WALTER WELLS

For shops that at times find it necessary to make precision measurements beyond the range of the popular 12-in. vernier calipers, the pair of homemade extensions illustrated will save purchasing calipers of a larger size. The extensions, or false jaws, are clamped positively into gaging position and do not seriously interfere with taking measurements within the 12-in. range. Their design combines the lightest possible weight with adequate rigidity, and incidentally minimizes the amount of precision work to be done on them.



Increasing the usefulness of standard vernier calipers by easily made extensions

The extensions are made from $\frac{5}{16}$-in. flat steel. The one at *A* is attached to the fixed jaw of the caliper and is considerably longer than is the one at *B*. To make the one at *B* longer than is shown would be to invite exaggerated "shake" effects when gaging. Both extensions are reduced in weight by cutting out the metal in the center, leaving ribs. After careful heat-treatment to relieve possible strains, the extensions should be polished to be in keeping with tools of quality.

The shoulders for the hardened and ground gibs *C* and the channels for the gaging bits *D* should be finished at the same setting to insure the necessary parallelism. Time can be saved by making the distances between these points to scale measurement. The cover plates should be fitted so as to allow the regular jaws of the vernier to just slide in without shake. One of the gibs should be left about 0.020 in. oversize, so that it can be ground down enough to make the false jaws register with the precise inch readings of the vernier. The gaging bits should be ground and lapped to a tapping fit in the channels in which they are seated and should be secured by screws.

When checking the attachments, any convenient spacer block over 6½ in. can be used, or a reading can be taken from a height gage. When sufficient range can be covered by using the longer extension only, a simple clamping arrangement should be devised to secure a long-shanked gaging bit to the mov-

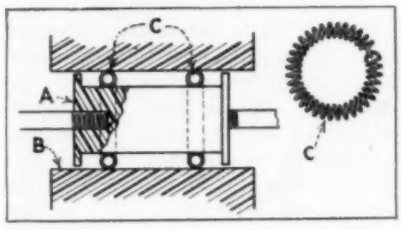
able jaw. Such a makeshift will extend the range of the caliper 33 per cent, while with both extensions its range will be extended 50 per cent.

Springs as Guiding Rollers

ERNEST C. ALLEN

When the stroke is not too great, a very efficient straight-line guide can be made as shown in the illustration. The movable member *A* is cylindrical in shape, and the guide *B* is a bored hole. Between these two members are placed the springs *C*, which act as rollers.

The springs should be made of music wire and of such diameter that they will fit very tightly in the available space.



If the springs are stretched, their diameter will be reduced slightly. If they are inserted when stretched and then released, they will contract in length and expand in diameter until they exactly fill the space. They can then be cut to length and the ends joined as shown. The result will be a non-friction guide that is entirely free from shake and possessing some slight resiliency.

Graduated Diemaker's Square

CHARLES WESLOW

In silverware, brass novelty, and some jewelry dies, such as are used for trimming an ornament out of a strip, considerable clearance is given in the die so that the struck-up ornament will fall through. Otherwise the next ornament placed in the die to be trimmed will smash the previous one that is going through the die, but that may be stuck. To prevent this at least five degrees clearance is given.

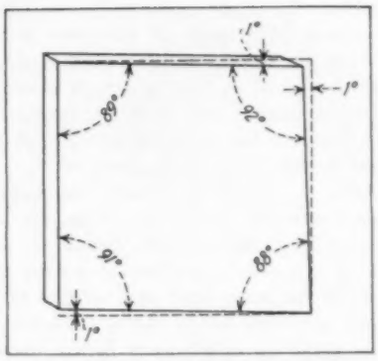


Fig. 3 — Angle block for checking die clearance angles on small bevels

In such dies and in a variety of die-casting, and some bakelite mold dies the square shown below comes in mighty handy as compared with the usual diemaker's square. For work of this kind the small square Fig. 1 will be found very useful. It not only has the advantage of a small blade so that the diemaker can look along the blade and see if the edge of the die or mold is machined or filed close to the edge but it is easily adjustable both as to length and angle.

The blade has a groove which should be ground parallel with the edge in which the pivoting screw point bears. The angle is secured by the graduated cam, the graduations running from zero to 8 deg. in both directions. In use the locking screw on top is loosened, the cam turned until the desired graduation comes under the knife edge of the blade, and the blade locked against the cam by the upper screw. Another design without graduations is seen in Fig. 2.

I also find it very convenient to have several "angle blocks" as in Fig. 3. They are of ⅛ in. steel, hardened, ground and lapped. I have them from 1 to 10 deg. both ways. They save time in setting up for any angle or for checking.

Feeding Thin Stock by Rolls

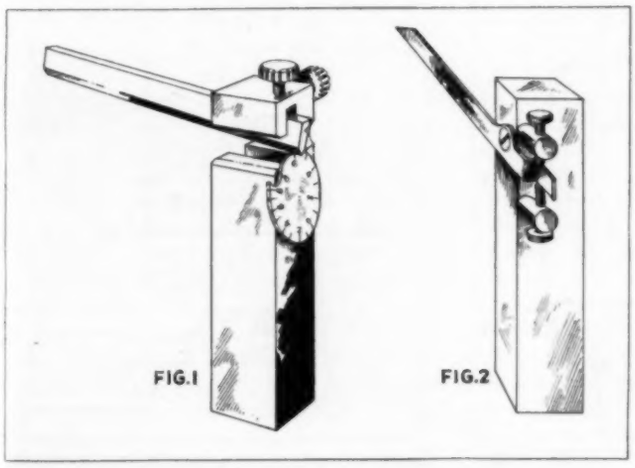
ANDREW BEUSCH

We have to make large quantities of shunts from copper strips 0.0005 in. thick and 1 in. wide, the strips being fed from left to right by feeding rolls.

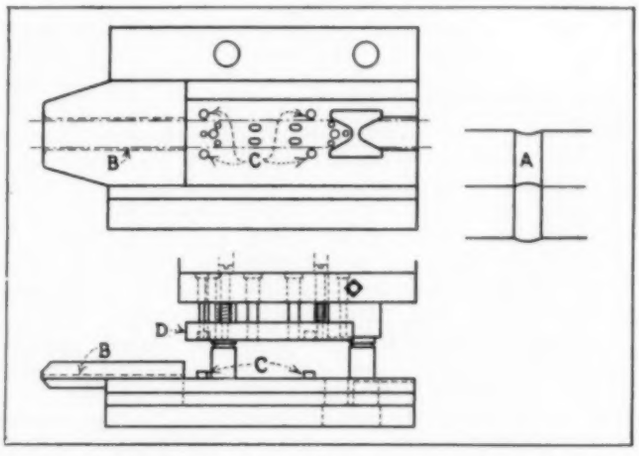
The original die was of standard design, equipped with the conventional stripper plate. We had considerable trouble with this die because the thin strip would get stuck in the stripper and would double up, accordion fashion, as the rolls continued to feed it. Since the stock is so thin and limber, the slightest burr on the end would make it refuse to pass under the stripper plate and it would double up between the feed rolls and the die.

To eliminate this trouble, the die was redesigned as shown in the illustration. The feed rolls were made as at *A*, their curved surfaces bending the strip and stiffening it before it entered the guide *B*. The stripper plate was omitted, the strip being located by the four pins *C*. The spring stripper *D* contacts with the strip and flattens the curve put into it by the feed rolls before the piercing punches and the cut-off punch contact with it. Since the die is open, very little resistance is offered to the strip as it is fed by the rolls, and the old trouble has been entirely eliminated.

This is one of the cases where it is necessary to perform an operation that has no bearing on the finished piece, and may be compared to machining locating points that are only useful during production.



Figs. 1 and 2—Adjustable die makers squares, one with a cam graduated to show degrees in either direction



Special feed rolls for feeding copper strips a half-thousandth thick, stiffening the strip before feeding

Rebabbitting Driving Box Hub Faces

F. M. A'HEARN

From time to time, the advisability of using babbitt metal or similar alloy on the hub faces of locomotive driving-boxes has been mentioned in *American Machinist*. At the same time, there seems to be some doubt as to the service life to be secured from babbitt metal as compared with bronze or other alloys when used as hub wear-plates. It is intended in this article to describe the method of renewing the hub faces with the wheels in place, and not to discuss the merits of babbitt as a hub metal, beyond stating that experience gained by observation of both bronze and babbitt wear plates shows the babbitted jobs to be satisfactory; also, that babbitt plates have been used on bubs that were formerly faced with bronze and have shown good results. This applies to both light and quite heavy types of 2-10-2 locomotives, as well as to heavier ones.

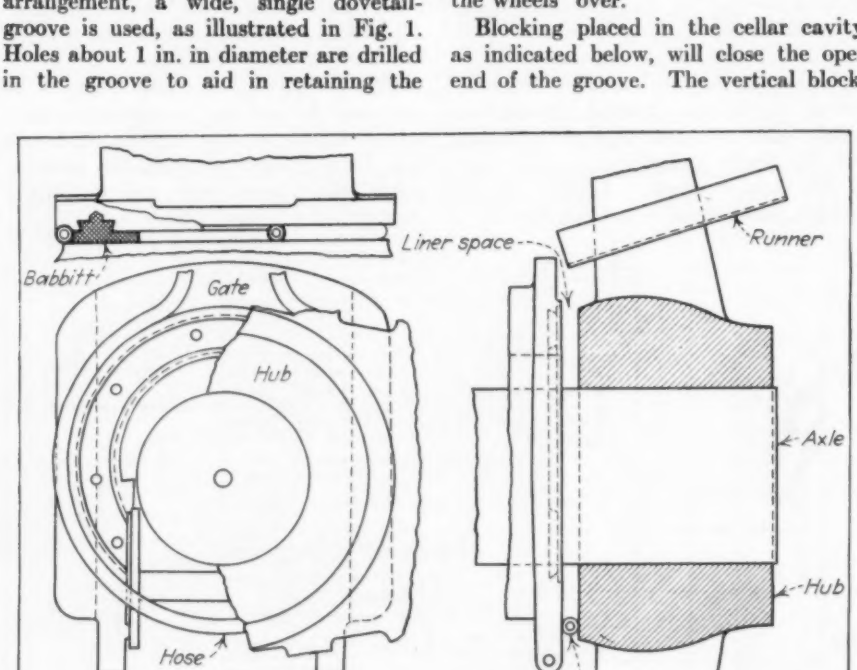
Wheel hubs are finished on their inner faces to a running bearing-face. No plates or liners are used on the wheels because the wheel fits on large axles are, at the best, none too long. Besides, it is obviously easier to make repairs on the smaller pieces of the wheel assembly than on the larger. The hub faces on the boxes have dovetailed seats to receive the babbitt in a manner similar to that where bronze is used. Where possible, a dovetailed or undercut outer rim should surround the hub metal. Where space does not permit this arrangement, a wide, single dovetail-groove is used, as illustrated in Fig. 1. Holes about 1 in. in diameter are drilled in the groove to aid in retaining the babbitt. In some cases, a bronze plug is driven into each of the two holes nearest the cellar opening. The plugs are covered when the babbitt it poured. This practice is not entirely necessary and hinders the removal of the plate when overhauling the locomotive.

After the boxes have been demounted from the axles, they may be set up for pouring, by the use of forms or by ramming a wooden pattern in a drag set to make an open-sand pour of the hub. Scrap car-brass lining metal of a fairly hard grade is satisfactory facing material. If too soft metal is used, a tendency to spread while in service may be noted. Antimony added to the metal used will give the desired degree of hardness. Before pouring, if oil holes are used to take oil from the top cavity of the driving box, taper pins or sand cores may be set in order to avoid drilling oil holes later.

Where excess hub lateral develops on any box without provision for reducing the lateral, except by a wheel drop and demounting the box, it means a sizable job for the roundhouse force. In such a case, one of the advantages of the babbitted hub face is found. The collar is removed and the old metal is melted from the box face by the use of a torch. Next, the drivers are positioned laterally to make the proper thickness of liner when the box is poured. On locomotives of ordinary size, a wedge driven between the wheel flange and the rail will often draw the wheel to place. On heavier engines the wedge may be entered and the locomotive can be moved to force the wheels over.

Blocking placed in the cellar cavity, as indicated below, will close the open end of the groove. The vertical blocks are notched to receive a section of deck hose to be used as a dam or collar. Thus the blocks aid in holding the hose in place. By means of a thin board or a strip of iron, the hose may be jammed snugly between the wheel hub and the box to retain the babbitt. Clay is used in openings as needed. The ends of the hose are wedged at the top of the box, as shown, and are luted with clay to form a suitable pouring gate. Since the gate is directly at the top of the hub, and inside of the wheel, it cannot be reached for pouring. To overcome this difficulty, a V-shaped runner of thin sheet steel or stove-pipe stock, as shown at the top right, is fastened between the wheel spokes to transfer the metal to the gate. Thin sheet will not chill the metal.

A portable forge mounted on a wagon is used to melt the metal. The pot should be large enough to hold a surplus of metal, as a small runout may occur, and may be held in a double shank like a foundry ladle. In pouring, two hand ladles are used by two men who alternate in filling and pouring until the job is finished. In this way the flow of metal is constant and cold shuts or seams in the job are avoided. If the box on the opposite side is also to be relined, the wheels may be wedged far enough to give the necessary opening.

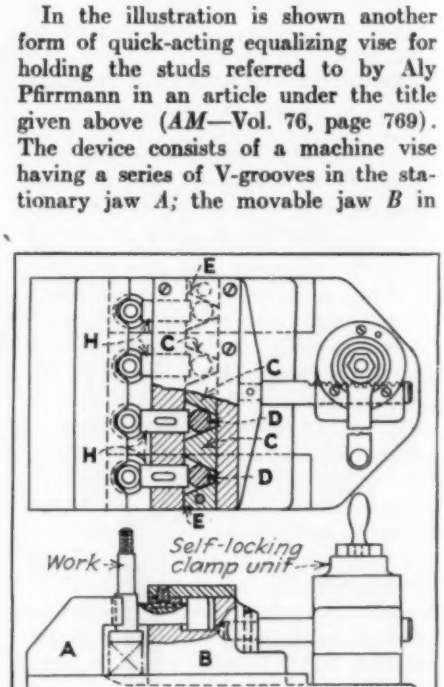


Molds used in pouring babbitt hub faces in driving boxes with the box in place on the axle. The babbitt is poured between the spokes

A Quick-Acting Equalizing Vise

DUDLEY L. CURTIS

In the illustration is shown another form of quick-acting equalizing vise for holding the studs referred to by Aly Pfirrmann in an article under the title given above (*AM*—Vol. 76, page 769). The device consists of a machine vise having a series of V-grooves in the stationary jaw *A;* the movable jaw *B* in

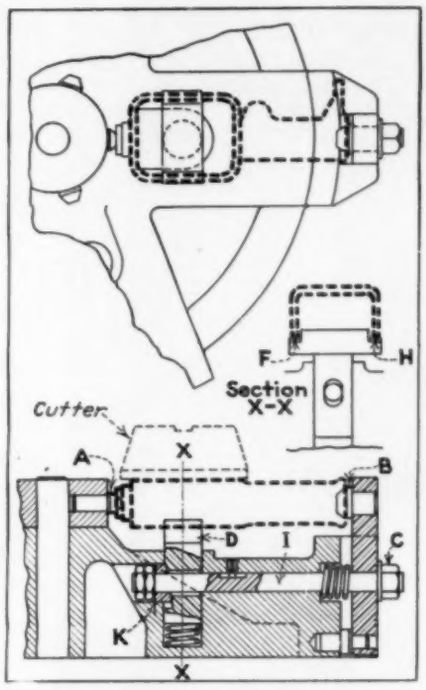


Using floating wedges and pins to equalize pressure on several pieces

which are located three floating, wedge-shaped blocks *C;* four floating pins *D,* held in position by the two fixed blocks *E;* and the plungers *H.* As the vise is closed, the pins press the plungers outward and clamp the work.

Since both the wedge-shaped blocks and the pins have a floating action, the plungers become self equalizing. If one plunger should contact with the work before any of the others, it would impart motion to the pin directly behind it. Thus, the floating, wedge-shaped blocks would be moved sidewise until the next plunger came into contact with the work, and so on until all the plungers clamped the work with equal pressure. The angular sides on the wedge-shaped blocks in connection with the pins, all of which float, permit the equalizing action of the plungers.

The movable jaw is operated by a standard, self-locking clamp unit through a pinion and a rack. If preferred, either a cam or a screw can be used to operate the movable jaw, although the self-locking clamp unit will be found to be both quick and positive. The same equalizing device will work very well in connection with multiple centers, any slight variation in the lengths of the work being compensated for by the equalizing action of the device.



By combining the plunger and clamp work can be easily and quickly clamped in a rotary milling fixture

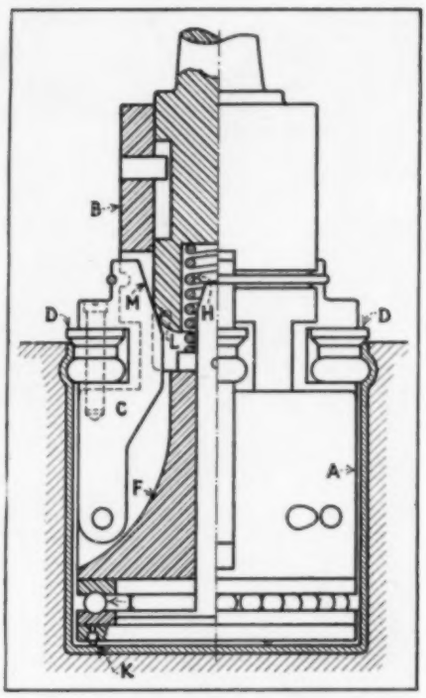
Fixture Having a Combination Clamp and Plunger

L. L. LOCKE

A rotary-type milling fixture having a clamp and a work-supporting plunger that function together is shown in the illustration. The fixture is for holding six cast-iron housings like the one indicated by heavy dotted lines, while the face is being milled. One station only is shown. The castings are located from cored openings at each end and are aligned crosswise from the bottom edges.

The work is inserted in the fixture so that the conical head of the stationary plug *A* enters the cored opening at one end. It is then held approximately level while the conical head of the plug *B* is entered in the cored opening in the opposite end. This plug is entered by tightening the nut *C,* operating the clamp in which the plug is mounted. With the work in place, the spring actuated plunger *D* bears against the two edges *F* and *H,* leveling it crosswise. Tightening the clamp draws the stud *I* outward and at the same time binds the wedge collar *K* against its tapered seat on the shank of the plunger, thus locking the plunger against the under side of the work.

This arrangement permits the clamp and the plunger to be operated in unison, a feature that is desirable in station type fixtures, so that the work can be fed at its maximum rate without preventing the operator from keeping up with loading and unloading. The same principle of combination locking can be applied to other types of fixtures, also to some types of jigs.



Locking a copper lining in a cylinder using a roller beading tool with a ball thrust bearing

A Roller Beading Tool

E. F. EBERHARD

To prevent leakage and corrosion in a cylindrical compartment of a high-pressure compressor, the copper lining *A* was put in. The lining was open at one end and was held in place by beading the open end into an annular groove in the upper end of the compartment by means of the tool illustrated. The tool was held in the spindle of a vertical drill and the bead was formed by feeding the tool downward.

Essentially, the tool consists of a shank to which the other members are attached; the sliding sleeve *B* carrying the four pivoted roller arms *C,* on which are mounted the beading rolls *D;* and the stop plate *F* for gaging the depth that the tool enters the lining. Until the tool reaches the bottom of the lining, the sleeve *B* is held in its lowest position on the shank by the spring *H.* At this time, the roller arms are at their inner position, so that the rolls clear the lining wall. When the tool is lowered far enough for the stop plate to contact with the ball thrust-bearing *I,* the three points *K* are brought into contact with the bottom of the lining, and further downward movement of the tool seats the lining in the bottom of the compartment.

Continued downward movement of the spindle causes the curved end *L* on the lower part of the shank to contact with the angular parts *M* of the roller arms and force them outward. Since the beading rolls are mounted on the roller arms, they are also forced outward and bead the lining into the annular groove. At the same time, the upper part of the lining is slightly beveled by the angular shoulders of the rolls. The ball thrust-bearing between the bottom of the stop plate and the bottom of the lining reduces friction at that point and provides a smoother action of the tool.

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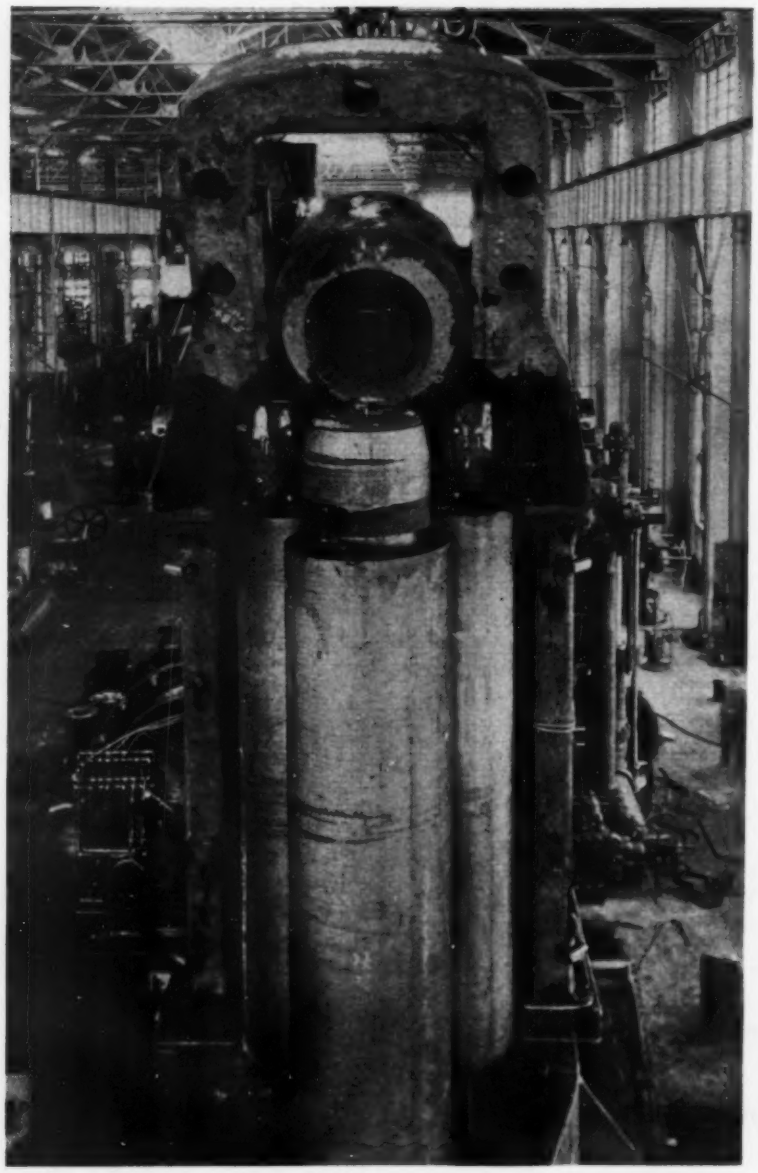
50 Million Thermometers

There seems to be very little connection between thermometers and 20,000 kw. power plants. But the new mercury turbine installed at the Kearney power station will require 540,000 lb. of mercury for its boilers, or enough for 50,000,000 household thermometers. The mercury is not used up as in the case of water filled boilers. Unless lost by accident it is used over and over again, being completely condensed after the vapor is used in the turbines. At the present rate of mercury production this installation will take over half a year's output.



Giant Bending Roll Aids Construction at Hoover Dam

Built by Baldwin-Southwark, this vertical bending roll will be used to fabricate penstocks 30 ft. in diameter from 2⅞ in. plate. The upper structure is shown turned upward and backward to permit removal of circular shells

BY FAR the largest engineering work of its kind, Hoover Dam, because of its very size, will require new methods of construction. One of the unusual features is the specification of all-steel conduits for the penstocks. These penstocks will lead water to the hydraulic turbines that will ultimately develop 1,835,000 hp. Ordinarily, concrete lined tunnels through the rock of the canyon walls would be employed for this purpose, but the engineers for Hoover Dam wanted steel conduit that could be inspected inside and outside. Building such conduit is a large task in itself, involving both large diameter and unusual wall thickness. The volume of water required for some of the turbines necessitates a pipe diameter of 30 ft., and 4,600 ft. of this size will be built, as well as a considerable quantity of pipe of smaller diameter. Water pressure of 250 lb. per sq.in. and the conditions of service caused the engineers to specify pipe wall thickness of approximately 3 in.

To fabricate 30-ft. pipe, 3 in. thick, and transport it to the job in sections is manifestly impossible, considering limitations of railroad facilities. Therefore, Babcock & Wilcox, the contractor, has set about erecting a fabricating plant near the dam site. Among the equipment ordered was a bending roll from the Baldwin-Southwark Corp. This machine is probably the largest vertical roll ever built and was recently shipped to the B & W plant at Bechtal, Nevada, a mile from the canyon rim.

The work of fabricating the conduit and installing it will take approximately four years. Actual thickness of plates to be handled by the bending roll is 2⅞ in. Circumference of the penstock is about 96 ft., and since the maximum plate that can be rolled and transported is about 35x12 ft., weighing nearly 25 tons, it was decided to make each erection section of six plates; three in each of two rings with three 12 ft. longitudinal welds in each ring. These rings are then to be welded together circumferentially to form a section 30 ft. in diameter by 24 ft. long and weighing about 150 tons. The size and weight of the plates required a vertical bending roll, because handling of the plate into and above the rolls is easier, and because the weight of the plate during rolling is carried by the foundation and not by the machine.

The outer roll of the machine is 40 in. in diameter for 12 ft. 6 in. of its

length and has journals 22 in. in diameter by 24 in. long. The bearings are of special bronze and are pressure grease lubricated. Weight of this roll with the top bearing and bearing shell is about 65,000 lb. It is mounted on a roller thrust bearing, and so little friction is encountered that one man can rotate the roll by pushing it with his hands. The outer roll is not driven from the motor supplying power for the rolling operation. It is rotated by friction between itself and the plate. To it at the ends, however, are connected the screwdown yokes through which the plate to be rolled is loaded and bent. The two inner rolls are driven and are 32 in. in diameter for 12 ft. 6 in. of length and have journals 16 in. diameter by 22 in. long. The bearings are solid.

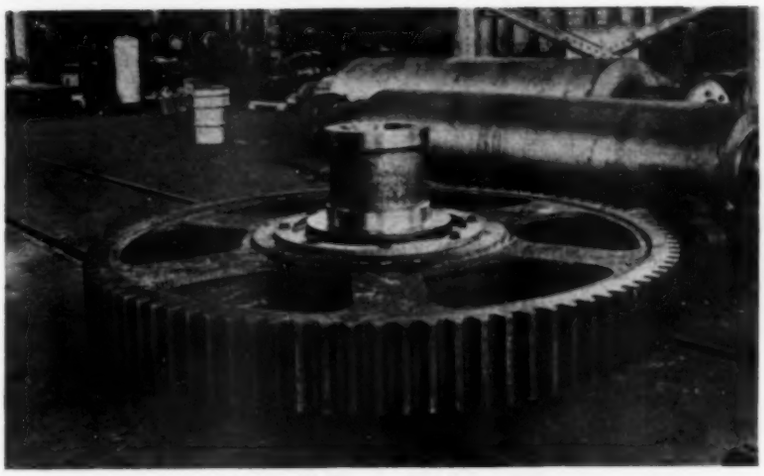
The floor level of the installed machine is the plane surface at the lower end of the rolls. Therefore, it is obvious that much of the main roll drive is below the floor level. To facilitate inspection and access, provision is made that the entire gear box may be lowered a few inches to rails set in the foundation and then may be moved laterally from under the machine so that access may be had from above into the gear box. To make possible this convenience, it was necessary to provide a readily separable coupling between the gearbox shafts and the two inner rolls.

Screw-Down Mechanism

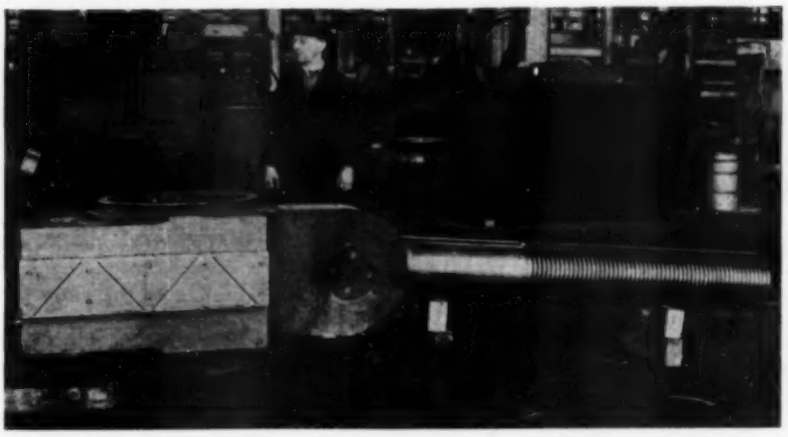
An important part of the Southwark bending roll is the screwdown mechanism. This consists of a 100-hp. motor, gearing, large nuts and screws and is used to bend the plate initially before the rolling operation is started. When rolling, a progressive bending takes place from end to end of the plate. After one or more passes, the screwdown is operated to draw the outer roll closer to the two inner rolls and thus to increase the depth of the segment of the circle of which the plate surface is a part. This procedure is continued until the required radius is obtained.

It is not possible, however, on any type of bending to roll a true radius at the ends of heavy plate. There is always a straight portion. Since the plates for the penstocks must form true cylindrical shells, on account of welded construction, it was necessary to provide a die to permit crimping the plate to the proper radius at the ends. This die is a steel casting supported by the inner rolls and having a much shorter "span" than that provided by the inner rolls. When crimping, the screwdown load is 3,300,000 lb., but during tests a load of 5,700,000 lb. was measured.

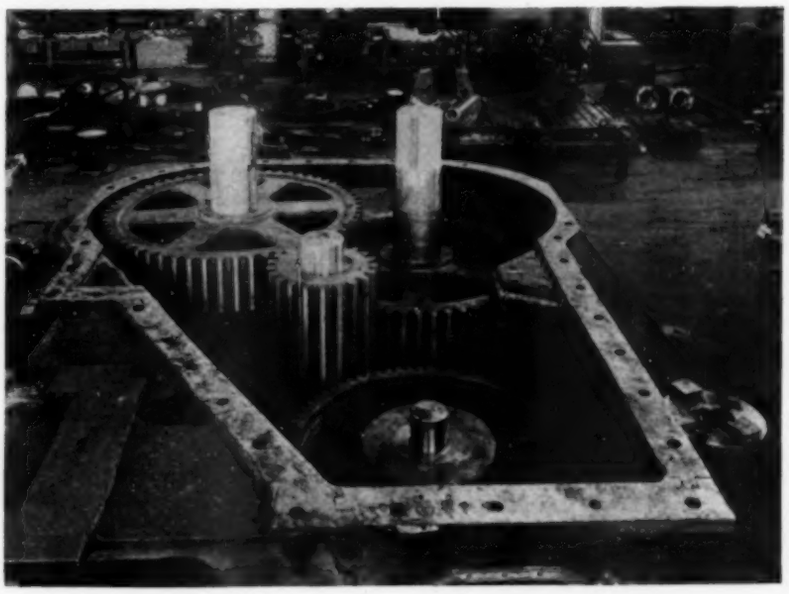
Weight of the machine is 500,000 lb. with the electrical equipment.



One of the two screw-down gears is shown assembled to the bronze nut that fits the large screw below. The nut is 36 in. long. During rolling a load of 1,500,000 lb. is applied to the outer roll. Plate speed is 10 ft. per min.



The screw for the screw-down mechanism is 13 in. in diameter. It is shown assembled to its yoke and outer roll bearing



Inner-roll-drive gearbox which can be dropped to rails and withdrawn for inspection. Separable couplings are used between the drive shafts and the inner rolls

SHOP EQUIPMENT NEWS

Thompson Fully Hydraulic Surface Grinders

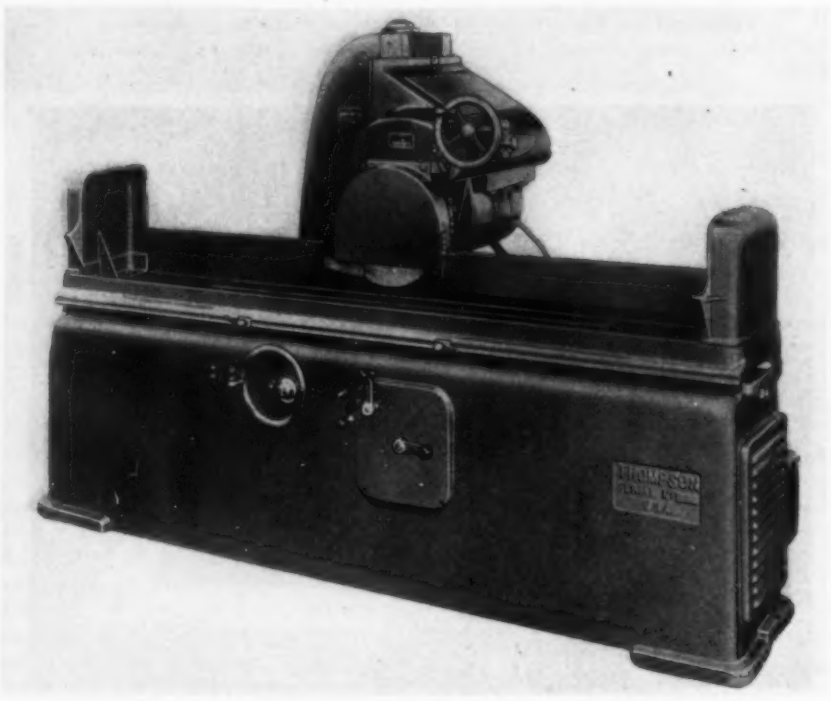
Complete hydraulic operation of its surface grinders has been achieved by The Thompson Grinder Co., Springfield, Ohio. Both the table and wheelhead are traversed at a speed easily variable. Reversal of the table is accomplished by dogs without shock or dwell, and with an accuracy which permits grinding of parts having close interferences on the ends. Traverse of the grinding wheelhead is controlled from the front panel and may be either intermittent at a variable rate or continuous in either direction. The line includes a 12x16x40 in. machine, an 8x12x24 in. machine, and a 6x12x18 in. machine. A 12x16x60 in. machine was also developed with a large diameter grinding wheel for grinding dies from which guide pins have not been removed.

The 8x12x24 in. model is efficient as a toolroom or production unit. In addition to the standard, automatic, hydraulic, intermittent and truing feeds, the head may also be moved by means of a handwheel on the wheelhead bracket. The 6x12x18 in. machine has automatic power cross feed as an optional feature and is generally intended for toolroom use where exceptional accuracy is required. The operator's entire attention may be devoted to one function; that of cross feeding to the limit on the handwheel. Hydraulic automatic cross feed can be supplied at a small cost.

In the grinding wheelhead, the motor-on-spindle feature eliminates vibration and delivers maximum power. The front spindle bearing is an adjustable bronze type, while the rear of the spindle is carried on precision ball bearings. Both intermittent and continuous hydraulic cross feeds are provided. Intermittent feeding is graduated in increments of $\frac{1}{32}$ in. per reverse to 65 per cent of the wheel width. The head bracket is fitted with adjustable stop dogs for shoulder or slot grinding. By adjusting similar dogs, the wheelhead may be automatically reversed during its feeding movement. Continuous feed or wheel truing speed may be obtained by operating a lever in the front panel. A manual feed is also provided for form or shoulder grinding.

All operating functions are controlled from the central valve panel. Motors are provided with automatic starters having overload and undervoltage protection and are controlled by pushbuttons. Table speeds are 10 to 100 ft. per minute on all machines. Automatic hydraulic feed of the 12x16x40 in. unit is $\frac{1}{32}$ to 2 in.; of the 8x12x24 in. unit, $\frac{1}{32}$ to 1 in., and of the 6x12x18 in. unit from $\frac{1}{32}$ to $\frac{3}{4}$ in., as an optional feature.

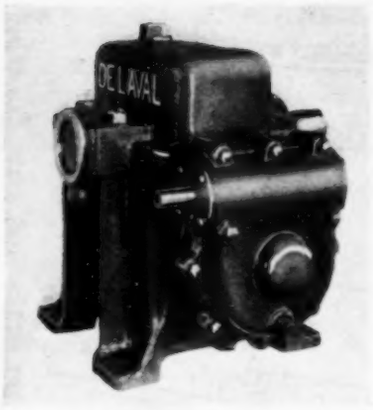
Thompson 6x12x18-In. Hydraulic Surface Grinder with the front splash shield removed



Dies can be reground without removing guide pins on the Thompson 12x16x60-In. Fully Hydraulic Surface Grinder, using either the hydraulic automatic feed with stops and reverse or the hand feed

DeLaval Worm-Gear Double-Reduction Units

In the line of double-reduction worm gears just placed on the market by the DeLaval Steam Turbine Co., Trenton, N. J., the simplicity of the combined double-reduction design has been retained, the high-speed gear wheel being



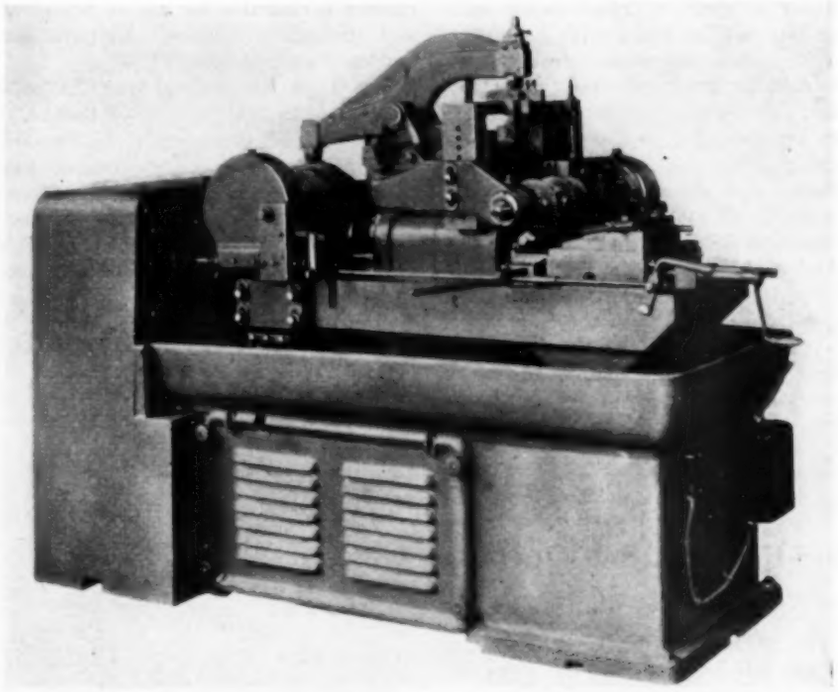
DeLaval Double-Reduction Worm Gear with slow speed shaft horizontal

mounted upon the slow speed worm shaft. However, a greater flexibility in the arrangement of the drive has been gained by using separate housings for the high speed gear and the slow speed gear. For example, the unit with vertical slow speed shaft can be combined in six ways, namely: with the high-speed shaft at the right and with the vertical driven shaft extending either upward or downward, or in both directions, and similarly with the high-speed shaft at the left. The unit with the horizontal slow-speed shaft can have the high-speed driving shaft extended in either or both directions, and likewise the slow-speed shaft.

The worm can be rotated either clockwise or counter-clockwise, facing the worm from the motor or driving position. Standard gear sets are cut with right-hand threads. All gear tooth and worm surfaces and the bearings are lubricated by splash. The high-speed worm shaft and the shaft which carries the high-speed gear wheel and the slow-speed worm have ball bearings. The slow-speed shaft has plain sleeve bearings, or, when the slow-speed shaft is horizontal, with tapered roller bearings.

Producto-Matic No. 35 Automatic Indexing Milling Machine

A number of slots or surfaces on the periphery or face of a part can be milled on the No. 35 Producto-Matic milling machine that has just been placed on the market by the Producto Machine Co., Bridgeport, Conn. Incorporated in this machine are the usual features of the Producto-Matic line; that is, full automatic operation controlled by cams; feeding of the cutters both vertically and horizontally so that the cutters first feed to depth and then travel forward to finish the cut, rise out of the cut and return clear of the work while indexing takes place. The only manual operation is to place the work on arbors or in the work locating collet.



Slots or surfaces can be milled on the periphery or face of parts up to 4 in. in diameter on the Producto-Matic No. 35 Automatic Indexing Milling Machine

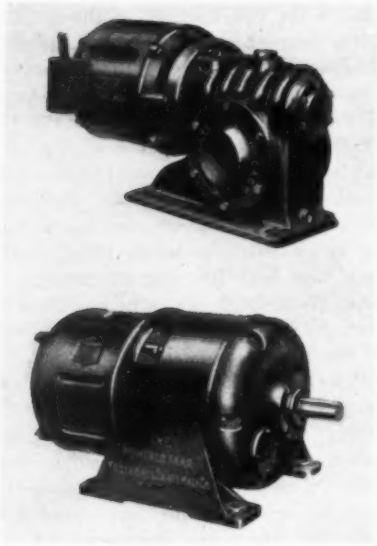
This machine is supplied with a multiple headstock having two, three or four spindles. In any case the maximum diameter of work accommodated is 4 in. The quick-acting tailstock is adjustable along the bed for various lengths of work. Work locaters can be mounted between the head and tailstock to locate the stock from any given point.

This machine provides a 5-in. horizontal and a 2-in. vertical stroke of the cutters. These movements are controlled from cams on the single camshaft. These are the only cams that need be removed for any variety of work and they are simply keyed and held by hardened screws on the shaft.

The cabinet-type base incloses all units. Its dimensions are 64 in. long by 32 in. wide. The transmission case, bolted to the end of the cabinet base, is a sheet metal housing with welded sections. A 3-hp. motor running at 1,750 r.p.m. is used. Throughout the transmission three steps or cone pulleys are employed in every case, and a cog belt is used on all pulleys. Including the groove pulley on the motor shaft, there are nine separate V-pulleys used in the entire transmission with various combinations of step pulleys. Nine changes of cutter speeds are secured and nine changes of feeds are obtained. Cutter spindle speeds range from 42 to 500 r.p.m. With the same pulley combination, the variations in camshaft speeds that control the feed of the cutters have a range of 9 to 65 seconds per revolution of camshaft. Thus, a wide variety of feeds and speeds is secured to give almost any possible combination of milling. In this way roughing cuts are secured and finishing cuts can be so regulated as to leave a very fine finish on the work. A tension device keeps all belts properly tightened.

"IXL" Motorized Speed Reducers

Under the trade mark "IXL Powered Gear," a complete line of motorized reduction units has been placed on the market through the auspices of Abel Davis and Franklin H. Fowler, receivers for the Foote Bros. Gear & Machine Co., 5301 S. Western Blvd., Chicago, Ill. This line covers types ranging from ½ to 150 hp. capacity and ratios from 2 to 1 up to 3,600 to 1, the various types offered permitting use with right-angle, straight line, or offset drives, either horizontal or vertical. Motor characteristics may be varied to suit the particular



Above — "IXL" Radiating Worm Type Powered Gear. Below — Helical Gear Type Powered Gear

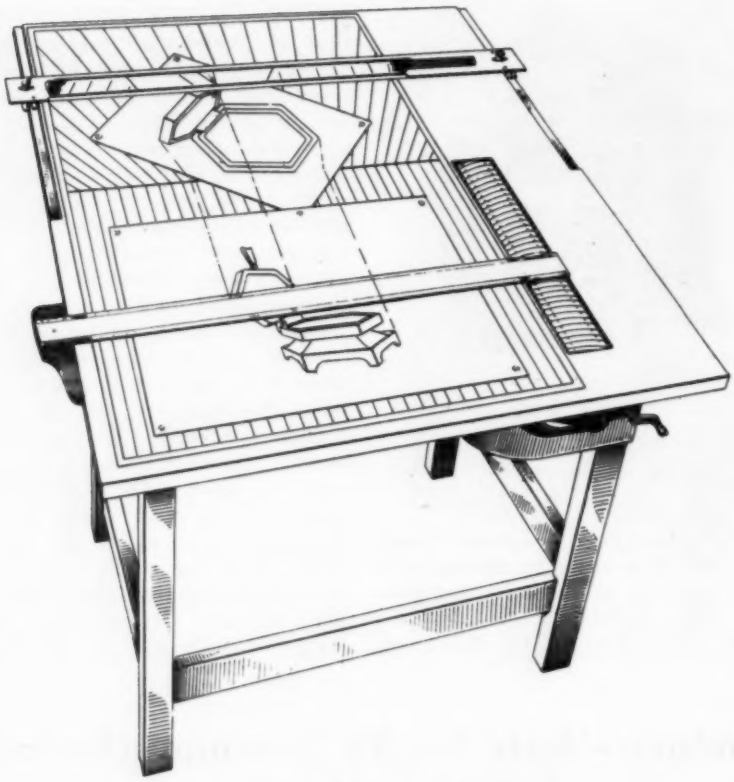
application, including normal starting torque, high starting torque, high slip, adjustable speed and multi-speed.

There are two main divisions of this line, the radiating worm-gear type and the helical gear type. The worm gear line covers ratios from 4 to 1, up to 60 to 1 single-reduction style and up to 3,600 to 1 in the double worm reduction type. Capacities are ½ to 25 hp. The built-in gear unit embodies the same design and construction features as the company's "Hygrade" worm reducers. The case design results in greatly increased heat radiating capacity that materially increases the continuous load ratings of the worm-type units.

The helical type is made in single, double, and triple-reduction ratios, providing a range of output speed from 4 to 850 r.p.m., and horsepower capacities up to 150 hp. Anti-friction bearings are used throughout in the standard design of units, but sleeve bearings may be supplied for special applications where extreme quietness of operation is essential.

Calibron Perspective Machine

Calibron Products, Inc., West Orange, N. J., has developed a machine for making perspective drawings accurately and rapidly. The equipment consists of a perspective drawing mechanism mounted on an especially constructed drafting table. The visible portion of this mechanism consists of a cylinder and sliding straight-edge mechanically connected together. On the drafting board there is fastened a sheet of specially ruled paper, the upper portion of which has



Drawings are quickly made in true perspective by means of the Calibron Perspective Machine

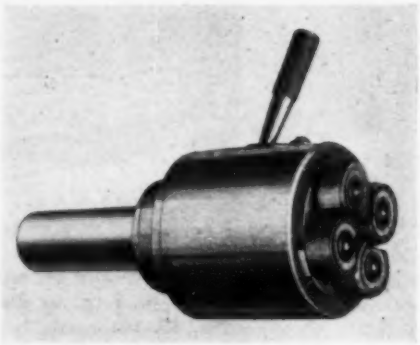
a series of converging straight lines intersecting vertical straight lines on the lower portion of the paper. The horizontal dividing line near the center of the paper represents the trace of the picture plane. There is attached to the cylinder a sheet of ruled paper with lines representing perspective heights.

Three simple operations are necessary to obtain the perspective position of any point, as follows: (1) Set the straight-edge on the point in the plan view by turning the crank which operates the cylinder and sliding straight-edge; (2) Project horizontally the corresponding perspective height of this point from the cylinder chart, using a T-square; (3) Follow the lines on the specially ruled paper from the point on the plan to the T-square to find the desired perspective point. The principal points are found in the above manner, and by connecting them, a true perspective is obtained.

Murchey Type RG Non-Rotating Self-Opening Diehead

The Murchey Machine & Tool Co., Detroit, Mich., is offering the Type RG non-rotating self-opening diehead as a companion head to the Type RC rotating diehead. The Type RG is designed to be used on hand screw machines or automatic machines where the diehead does not revolve. This tool takes the same chasers, size for size, as well as many of the parts of the Type RC, offering complete interchangeability in automatic shops where one stock of chasers is desirable for use on both live and stationary spindles. All parts are hardened and ground.

The Type RG diehead is of the pull-off type, being opened by a self-contained trip actuated by retarding the forward movement of the die spindle at any point. The opening is always positive and instantaneous. An internal trip may be installed, if required. The head is closed automatically by lateral movement when the closing handle engages a stop on the machine or by hand. A suitable range of size adjustment is



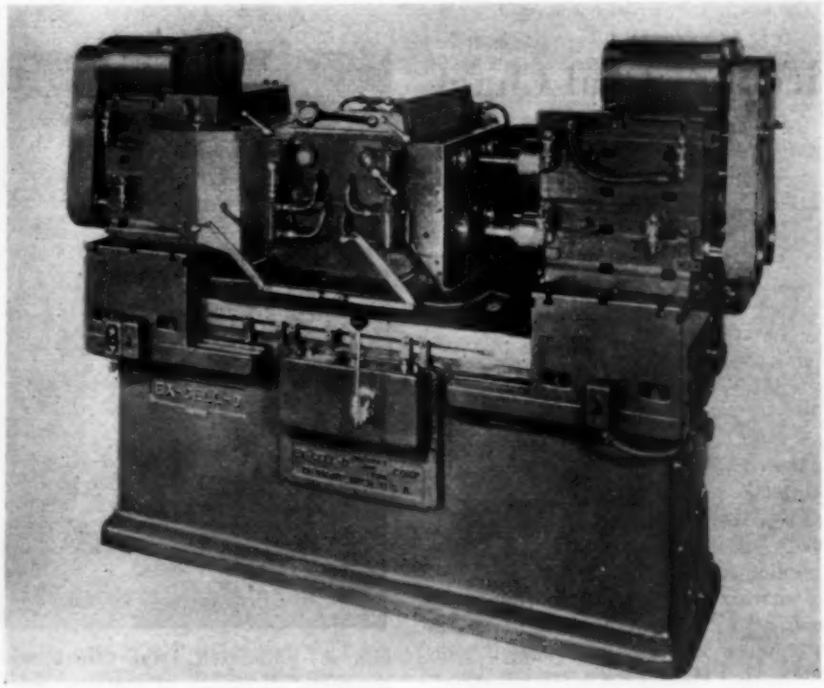
built into this head, making it possible to cut tight or loose fitting threads or to adjust to size after chaser grinding.

The diehead need not be changed for cutting right or left-hand threads, but separate chasers and chaser blocks are necessary to cut left-hand threads. The Type RG will be made in sizes from ⅞ in. up to and including 1¼ in. in diameter. With the Murchey circular chaser diehead, ground thread chasers are standard. The chasers may be reground practically for the total circumference.

Ex-Cell-O Precision Boring Machine for Steel

The Ex-Cell-O Aircraft & Tool Corp., 1200 Oakman Blvd., Detroit, Mich., announces that it can now bore steel with its single- and double-end precision boring machines. It has been found that steel parts, which do not exceed a hardness of 250 Brinell, 36 Scleroscope or 24 Rockwell, can be successfully bored, providing that the hardness of the steel is uniform, and that the stock to be removed is well distributed throughout the entire bore. Illustrated is a double-end machine designed for finish boring both the large and small end of a connecting rod in one operation. On the large end the material to be bored is steel and on the small end bronze. Approximately 0.018 in. to 0.020 in. of steel stock and 0.008 in. to 0.010 in. of bronze stock is removed.

The holding fixture is designed so that two rods are loaded at each end in a vertical position with the small end of the rod at the top. This enables the operator to load two rods at one end while two rods are being bored at the opposite end, eliminating the loading time. An in-built direct-connected electric motor drives the unit for boring the bronze end of the rod. This unit is located at the top of the mounting bracket. At the bottom of this bracket is located a belt-driven boring spindle for boring the steel end of the rod. The motor for driving this spindle is mounted on top of the bracket. By means of the belt-driven spindle the proper boring speed can be obtained for the steel end of the rod. There are two sets of these units at each end of the machine.

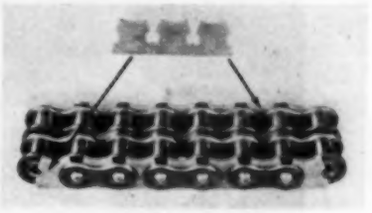


Ex-Cell-O setup for finish boring the steel large end and the bronze small end of a connecting rod, two rods at a time

Whitney Anti-Back-Bend Chain

The Whitney Mfg. Co., Hartford, Conn., has developed a device for the prevention of vibration and whip in roller and silent chain drives. The device consists of a small wedge-like element which is assembled into standard chains at every pitch. The wedges contact end to end and form a continuous stiff backbone throughout the length of the chain.

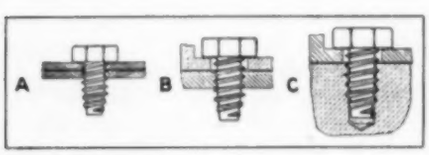
The elements float on the chain rivets and do not interfere with the normal chain joint action. They serve as check links to prevent back bend and chain whip or thrash when the load on the chain is of a pulsating nature. Chains in which the no-back-bend check links are assembled will run on standard sprockets and will interchange on practically every drive where the standard flexible chain, contacting the sprockets on one chain face only, has been used.



Whitney chain fitted with wedge-like element to prevent whip

Parker-Kalon Self-Tapping Capscrews

The line of self-tapping screws made by Parker-Kalon Corp., 200 Varick St., New York, N. Y., has been extended by adding self-tapping capscrews which can be used to make fastenings to sheet metal from 24 gage to 10 gage; to steel plate and structural shapes up to ½ in. thick, and to solid sections of brass, bronze, aluminum and die-castings, slate, transite board, and ebony asbestos. These capscrews are made in a range of sizes from No. 6 to ½ in. in diameter. These hardened, hexagon head self-tapping capscrews eliminate tapping—they form their own thread in the material as they are turned in. It is only necessary to punch or drill holes in the parts to be assembled and turn them in.



Typical assemblies made with Parker-Kalon self-tapping capscrews: A — Light sheet metal assembly; B—Fastening to heavy plate or structural shape; C—Fastening to aluminum casting or the like

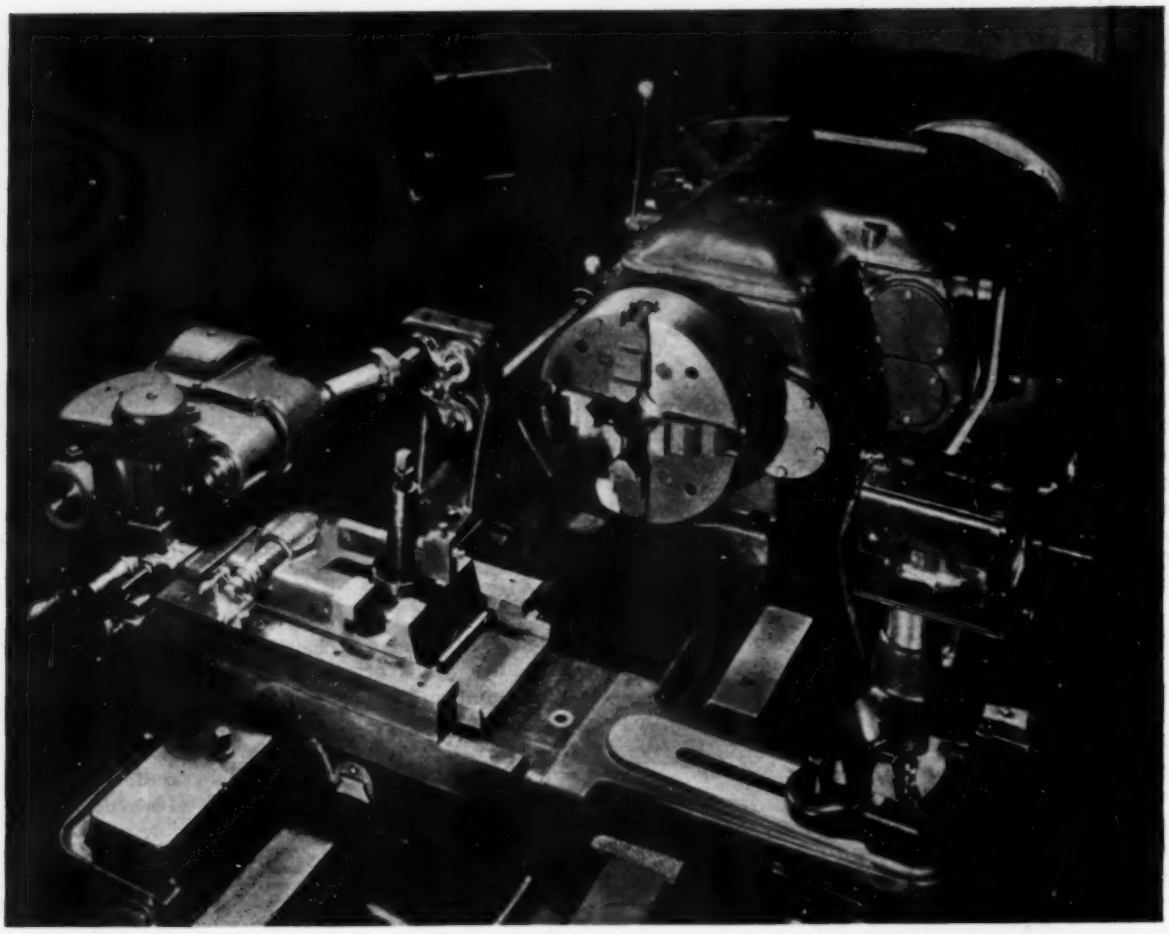


Fig. 1—Ovals, triangles, squares, hexagons and octagons, with either flat, concave or convex sides, can be produced with the aid of the Monarch Centrode Device. If the device is applied to the Monarch-Keller form-turning machine, irregular contours and shapes other than round can be produced

Monarch Centrode Device and Oval Chuck

Turning, boring and facing shapes other than round—ovals, triangles, squares, hexagons and octagons, with sides either flat, concave or convex, can be done with the "Centrode Device" developed by the Monarch Machine Tool Co., Sidney, Ohio. This unit, Fig. 1, can be applied to the Monarch lathes, Model "BB," 23 in. swing or larger. It can be applied only to new lathes.

If the work is irregular in contour and is in shapes other than round, the Monarch-Keller automatic form turning machine (*AM*—Vol. 73, p. 873) in combination with the Centrode Device, will turn, bore or face the contour automatically, and at the same time produce the odd shapes. The addition of the oval chuck, Fig. 3, to this combination permits production of many elongated shapes.

A graduated scale is provided on the Centrode Device for setting to a predetermined stroke. The stroke capacity ranges from 0 to 2 in. An index plate makes it easy to set quickly the number of flutes or tool actuations per revolution of the spindle in divisions from 1 to 16. The device is supported on the carriage bridge in the same manner as a compound rest. By means of the cross feed screw, the unit can be positioned for diameters. Power is taken from the rear end of the lathe spindle through a universal joint and spiral bevel pinions to the compound crank of the actuating toolslide.

The oval chuck, Fig. 3, can be supplied for all sizes of Monarch lathes, including the Monarch-Keller form-turning machine. When these chucks are applied to standard lathes, it is possible to produce all classes of straight contour ovals. When used on the Monarch-Keller form-turning machine it is possible to produce irregular contour oval

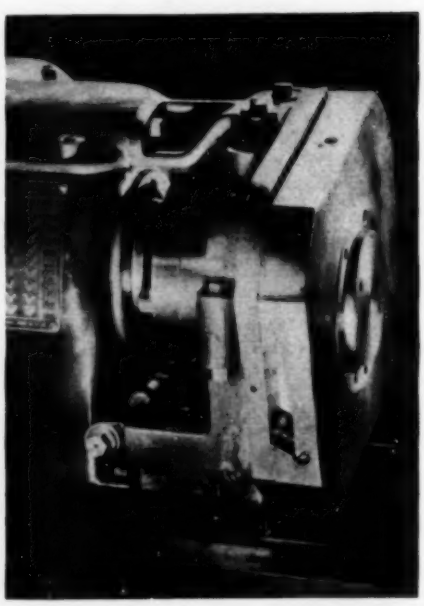


Fig. 3 — Monarch Oval Chuck which produces all classes of straight contour ovals, and which with the Centrode Device gives rise to more complex shapes

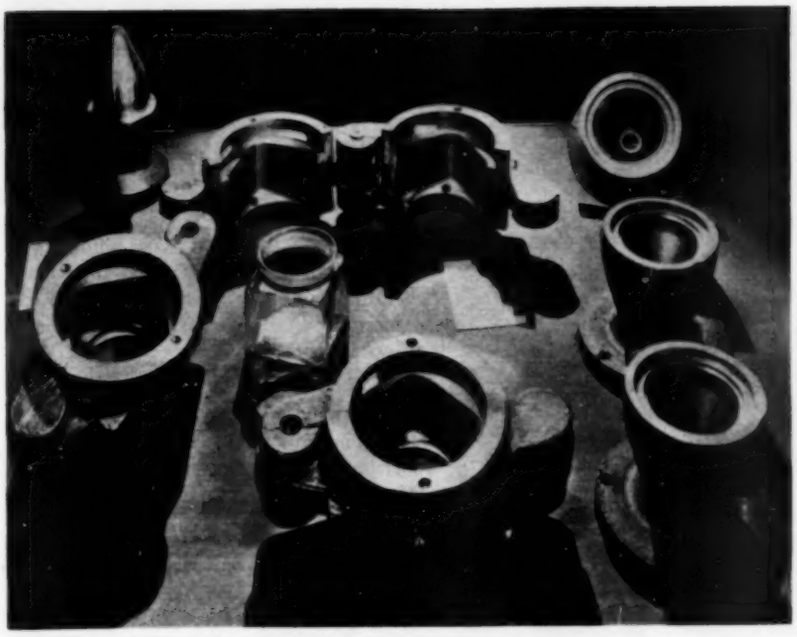


Fig. 2—Mold equipment for square jars was produced on a Monarch-Keller automatic form-turning machine equipped with the Monarch Centrode Device in 18 hr. and 10 min., as against 60 hr. by the former method

work. The front of the oval chuck has the same diameter tapered pilot as well as the same diameter of ground locating surface for holding chucks or fixtures as the flanged spindle nose of the lathe. Capacity of this chuck is a 2 in. throw, or a difference of 4 in. between the major and minor axes of the ellipse. Each fraction of an inch change in the stroke setting of the Centrode Device and each fractional change in the setting of the oval chuck produces a different shape.

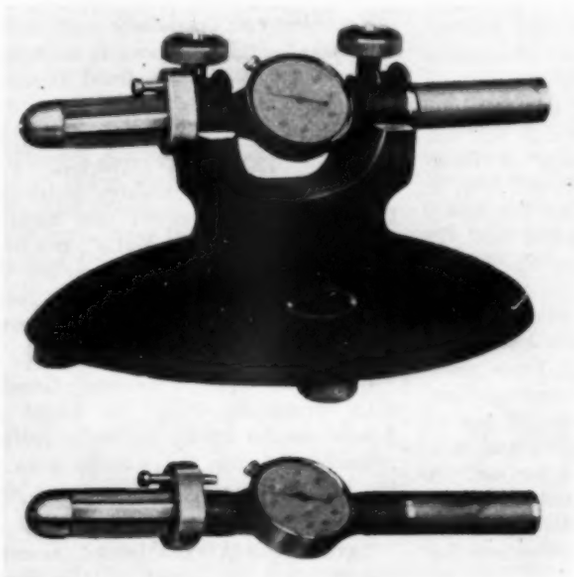
Formulas have been developed for calculating the correct stroke setting of the Centrode Device and the correct set-over for the oval chuck, in order to produce a very wide range of shapes. As mentioned, the Centrode Device can be furnished to give 16 tool actuations to one revolution of the work. When the device is used in combination with a Monarch speed reducer or sub-headstock, it will produce up to 96 tool actuations to one revolution of the work. A simple automatic stroke-changing device has been developed, whereby the same contour shapes can be turned and bored on work whose diameter is constantly changing.

"Standard" Dial Plug Gage

For measuring bore diameters, the Standard Gage Co., Poughkeepsie, N. Y., has developed a portable dial plug gage which can be used either by the operator on the machine or by the inspector as a bench comparator. This gage consists of a plug gage unit and a dial indicating unit. The mechanism of the plug gage unit is self-contained and is automatically self-aligning with respect to the axis of the bore and indicates the diameter of the bore on its true center line. The gage is set with a master ring gage. It is possible to measure the full length of the bore, determining any tapered, bellmouth or out of round condition, as well as go or no go limits.

The plug gage unit is provided with a pilot or rounded end to facilitate quick and easy entry into the bore, thus enabling the operator to measure the work while the machine is in operation. This unit is also equipped with an adjustable stop for different lengths of bores. Various sizes are made ranging from $\frac{5}{8}$ in. diameter up and for any length of bore. Each plug unit is adjustable to compensate for wear, change of tolerances or dimensions within its range. It is furnished with tungsten-carbide-tipped gaging surfaces and a diamond-tipped indicating contact point.

The indicating unit can be furnished with any "Standard" No. 1 or No. 2 dial indicator, graduated in 0.0001 in., 0.0005 in., 0.001 in. or in metric graduations. Each indicating unit is interchangeable with several sizes of the plug gage units. Applications of the dial plug gage are for measuring work such as ball bearings, roller bearings, bushings, cylinder bores, piston pin bores, gun bores. Special long handles for checking deep bores with the dial indicator mounted in any suitable position can be furnished.



Standard dial plug gage shown separately and also mounted on a stand for use as a bench comparator

Thor Electric Hammer

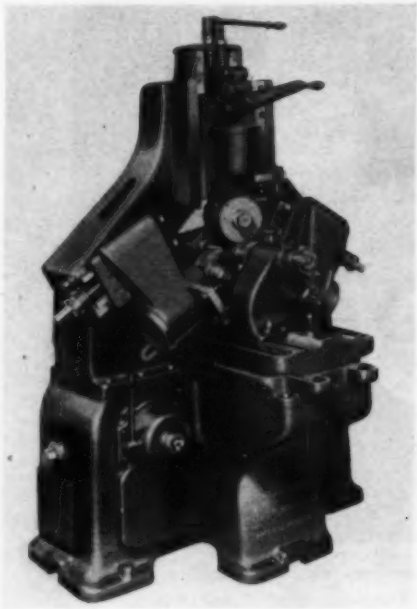
The Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill., has developed the "Thor" electric hammer, a double-purpose tool that can be used as a drill or hammer. Specifications are as follows: Blows per minute, 3,000; length over-all, 18 in.; weight, complete, 16 lb.; equipment furnished, $\frac{1}{4}$-in. Jacobs chuck, $\frac{5}{8}$-in. star drill, toolholder and ejector pin, and carrying case.

Michigan Gear-Lapping Machine

Three laps are used in a gear-lapping machine recently designed by the Michigan Tool Co., 7171 Six Mile Road, East, Detroit, Mich. These laps are spaced about equally around the work. Each of them may be set with its axis at an angle to the axis of the work, thereby producing a sliding action between the lap and gear teeth. The upper lap is raised and lowered by means of a handle for loading and unloading the machine.

A hydraulic brake on each lap-spindle may be set to any predetermined pressure for speeding up lapping operations. The headstock and tailstock for supporting the work, either between centers or stub arbors, are mounted on a table which is oscillated at various speeds. It is claimed that this function insures even lapping throughout the full length of gear teeth. Reloading is facilitated by an 8-in. movement of the tailstock spindle.

The machine is almost entirely automatic. Means are provided in the control box for setting the length of time it is desired to lap each side of gear teeth. The time may be equal for each side, or different. The machine can be set to change automatically from lapping one side of the gear teeth to lapping the opposite side. It is said that a production of about fifty gears of 10-pitch and 3 in. pitch diameter can be obtained per hour.



The work is rotated between three laps on the Michigan Gear-Lapping Machine. A hydraulic brake is provided on each lap-spindle

Carboloy Alloy 548

Although not immediately available the new alloy 548, developed by the Carboloy Co., Inc., Detroit, Mich., and announced by Dr. Zay Jeffries at the Cleveland meeting of the A.S.S.T., will soon be put on the market. Qualities midway between high-speed steel and cemented carbide are indicated for the new material by preliminary production tests. The purpose is to fill a gap which exists in the tool materials now in use.

It is claimed that alloy 548 will cut materials beyond the range of those which high-speed steel cuts and that it also gives better results on the easier jobs such as soft steel and cast iron. It also shows improvement on the harder steels.

Alloy 548 is principally a combination of iron, tungsten and cobalt but differs from other alloys having these same basic metals in that it functions best when practically carbon-free. It can be melted, cast, forged, or rolled and then machined and heat-treated for use. A moderate price range permits it to be made into solid tools or cutters although inserts may also prove economical for some applications.

• TRADE •
PUBLICATIONS

ANNUAL REPORTS. Metropolitan Life Insurance Co., Policyholders Service Bureau, 1 Madison Ave., New York, N. Y., has published a report "Descriptive Information in Annual Reports to Stockholders," which deals with current practices in describing manufacturing processes and improvements, sales trends, new acquisitions, industrial relations, business conditions and other facts affecting the company in its operation when making an annual accounting to the owners.

BORING MACHINES. Bulletin 4549, issued by The Heald Machine Co., Worcester, Mass., illustrates pictorially the construction features and controls of the No. 47 "Bore-Matic" precision finish boring machine and describes the machine fully. Specifications are listed and a number of examples of representative work are illustrated.

GRINDERS. The Thompson Grinder Co., Springfield, Ohio, has issued an 8-page circular on its hydraulic surface grinders, showing the various sizes in the line, the hydraulic power unit employed, and listing the specifications.

LATHES AND ATTACHMENTS. General Catalog No. 93, issued by the South Bend Lathe Works, South Bend, Ind., is a 72-page catalog describing and pricing the entire line of lathes in sizes from 8 to 24 in. swing. Also included are illustrations and descriptions of the many attachments with which a screw-cutting lathe can be fitted. Altogether, 96 sizes and types of lathes are shown.

PHOSPHOR BRONZE. "Anaconda Phosphor Bronze," publication B-15, Second Edition, is now available from the American Brass Co., Waterbury, Conn. Physical properties, grades, and commercial shapes of this alloy are discussed.

MECHANICAL RUBBER GOODS. The Diamond Rubber Co., Inc., Akron, Ohio, has issued a 24-page "Buyer's Guide to Mechanical Rubber Goods," which lists standard stock sizes and list prices. Major products noted are belting, hose, and packing.

MOTORS. The Ideal Electric & Mfg. Co., Mansfield, Ohio, is distributing Bulletin No. 540 describing in full detail the "Self-Syn" motors, which are self-excited, self-synchronizing, self-contained, general-purpose synchronous motors.

SAFETY. Practices of several industrial organizations in connection with safety educational work are presented in a report entitled "Methods of Organizing and Conducting Industrial Safety Contests," published by the Policyholders Service Bureau, Metropolitan Life Insurance Co., 1 Madison Ave., New York, N. Y.

SCREW THREADS. Engineering Experiment Station, University of Illinois, Urbana, Ill., has issued Bulletin No. 247 entitled "An Experimental Investigation of the Friction of Screw Threads," priced at $0.35.

USED MACHINERY. Industrial Plants Corp., 25 Church St., New York, N. Y., is distributing a catalog listing equipment being offered in liquidating the foundry, machine shop and pattern shop of the Cresson-Morris Co., Philadelphia, manufacturer of machinery and transmissions.

WELDING SERVICE. Austin Co., 16112 Euclid Ave., Cleveland, Ohio, has issued a folder describing the service of the welding division of the company, and showing several examples of its work. It gives a comprehensive description of the advantages to be obtained through welded steel construction.

WELDING SETS. Leaflets L. 20555 and L. 20556 describe respectively the 300 and 400 amp., single-operator, gas-engine driven, stationary or portable, "FlexArc" welders. These sets are manufactured by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.